E1.28:ONWI-120

ONWI-120

ORIGINAL

COMPLETED
694

Gulf Coast Salt Domes Geologic Area Characterization Report Mississippi Study Area

Volume VI
Technical Report

July 1982

Law Engineering Testing Company
2749 Delk Road, S.E.
Marietta, GA 30067

ONWI
Office of Nuclear Waste Isolation

BATTELLE Project Management Division

BIBLIOGRAPHIC DATA

Law Engineering Testing Company, 1982. *Gulf Coast Salt Domes Geologic Area Characterization Report*, ONWI-120, Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes
Printed copy: A23
Microfiche copy: A01

BEST DOCUMENT AVAILABLE

ONWI-120

Gulf Coast Salt Domes
Geologic Area Characterization Report
Mississippi Study Area

Volume VI
Technical Report

July 1982

Law Engineering Testing Company
2749 Delk Road, S.E.
Marietta, GA 30067

This report was prepared by Law Engineering Testing Company under Subcontract E512-00400 with Battelle Project Management Division, Office of Nuclear Waste Isolation under Contract No. DE-AC06-RLO1830-ONWI with the U.S. Department of Energy. This contract was administered by the Battelle Office of Nuclear Waste Isolation.

I

BLANK PAGE

ABSTRACT

The Mississippi Geologic Area Characterization Report (ACR) is a compilation of data gathered during the Area Characterization phase of the Department of Energy's National Waste Terminal Storage program in salt.

The characterization of Gulf Coast Salt Domes as a potential site for storge of nuclear waste is an ongoing process. This report summarizes investigations covering an area of approximately 2,590 km^2 (1,000 mi^2). Subsequent phases of the program will focus on smaller land areas and fewer specific salt domes, with progressively more detailed investigations, possibly culminating with a license application to the Nuclear Regulatory Commission.

The data in this report are a result of drilling and sampling, geophysical and geologic field work, and intensive literature review. The ACR contains text discussing data usage, interpretations, results and conclusions based on available geologic and hydrologic data, and figures including diagrams showing data point locations, geologic and hydrologic maps, geologic cross sections, and other geologic and hydrologic information. An appendix contains raw data gathered during this phase of the project and used in the preparation of these reports.

BLANK PAGE

VOLUME VI
TABLE OF CONTENTS

Page

ABSTRACT iii

LIST OF TABLES vii

LIST OF FIGURES ix

GLOSSARY OF GEOLOGICAL TERMS xv

CONVERSION FACTORS xxxv

ABBREVIATIONS AND ACRONYMS xxxvi

12 GEOLOGIC CHARACTERIZATION OF THE MISSISSIPPI STUDY AREA 12-1

12.1 DESCRIPTION OF THE MISSISSIPPI STUDY AREA 12-1

12.2 GEOLOGY OF THE MISSISSIPPI STUDY AREA 12-7

- 12.2.1 PHYSIOGRAPHY AND GEOMORPHOLOGY 12-7
- 12.2.2 STRATIGRAPHY 12-20
- 12.2.3 STRUCTURE 12-80
- 12.2.4 SEISMICITY 12-132

12.3 MINERAL RESOURCES OF THE MISSISSIPPI STUDY AREA 12-140

- 12.3.1 HYDROCARBONS 12-140
- 12.3.2 MINERAL AGGREGATES 12-149
- 12.3.3 LIGNITE 12-150

12.4 SUMMARY OF THE MISSISSIPPI STUDY AREA 12-150

12.5 LIST OF REFERENCES CITED 12-153

13 GEOLOGIC CHARACTERIZATION OF SELECTED DOMES IN THE MISSISSIPPI STUDY AREA 13-1

13.1 CYPRESS CREEK DOME 13-1

- 13.1.1 DOME GEOMETRY AND COMPOSITION 13-1
- 13.1.2 NEAR-DOME GEOLOGY 13-15
- 13.1.3 MINERAL RESOURCES 13-56

13.2 LAMPTON DOME 13-59

- 13.2.1 DOME GEOMETRY AND COMPOSITION 13-59
- 13.2.2 NEAR-DOME GEOLOGY 13-77
- 13.2.3 MINERAL RESOURCES 13-94

VOLUME VI
TABLE OF CONTENTS (Continued)

Page

13.3 RICHTON DOME 13-96

  13.3.1 DOME GEOMETRY AND COMPOSITION 13-97
  13.3.2 NEAR-DOME GEOLOGY 13-118
  13.3.3 MINERAL RESOURCES 13-160

13.4 SUMMARY OF SELECTED DOMES 13-163

13.5 LIST OF REFERENCES CITED 13-165

14 HYDROLOGIC CHARACTERIZATION OF THE MISSISSIPPI STUDY AREA 14-1

14.1 HYDROLOGIC FIELD DATA COLLECTION PROGRAM, MISSISSIPPI STUDY AREA 14-2

  14.1.1 SURFACE WATER 14-7
  14.1.2 GROUND WATER 14-7
  14.1.3 WATER CHEMISTRY 14-8

14.2 REGIONAL HYDROLOGIC CHARACTERIZATION OF THE MISSISSIPPI STUDY AREA 14-8

  14.2.1 REGIONAL SURFACE-WATER HYDROLOGY 14-9
  14.2.2 REGIONAL GROUND-WATER HYDROLOGY 14-13
  14.2.3 WATER CHEMISTRY 14-35
  14.2.4 RELATIONSHIP OF SURFACE WATER TO GROUND WATER 14-44
  14.2.5 WATER AND AQUIFER USE 14-47

14.3 HYDROLOGIC CHARACTERIZATION OF SELECTED DOMES IN THE MISSISSIPPI STUDY 14-81

  14.3.1 RICHTON DOME 14-81
  14.3.2 CYPRESS CREEK DOME 14-103
  14.3.3 LAMPTON DOME 14-121

14.4 HYDROLOGIC CHARACTERIZATION SUMMARY OF THE MISSISSIPPI STUDY AREA 14-132

14.5 LIST OF REFERENCES CITED 14-139

VOLUME VI
LIST OF TABLES

Table No.	Title	Page
	Chapter 12	
12-1	Stratigraphic Chart	12-23
12-2	Borehole Data Summary	12-29
12-3	Names of Wells Used in Figures	12-100
12-4	Hydrocarbon Production for Mississippi Study Area	12-144
	Chapter 13	
13-1	Cypress Creek Dome Stratigraphic Chart	13-39
13-2	Lampton Dome Stratigraphic Chart	13-92
13-3	Richton Dome Stratigraphic Chart	13-140
	Chapter 14	
14-1	Generalized Stratigraphy and Water-Bearing Characteristics of Geologic Units in the Mississippi Study Area	14-17
14-2	Aquifer Test Summary for Selected Geologic Units	14-27
14-3	Summary of Water Chemistry Characteristics in the Fresh Water Aquifer System	14-39
14-4	Summary of Water Use	14-49
14-5	Selected High-Capacity Water Supply Wells in the Study Area	14-50
14-6	Saline Water Disposal Wells Within the Study Area	14-76
14-7	Dome Specific Aquifer Test Summary	14-94
14-8	Summary of Field Measurements Made on Streams in Vicinity of Candidate Salt Domes	14-118

BLANK PAGE

VIII

VOLUME VI
LIST OF FIGURES

Chapter 12

Figure No.	Title	Page
12-1	Location Map	12-3
12-2	Topographic Map	12-5
12-3	Regional Physiographic Features	12-9
12-4	Physiographic Map	12-10
12-5	Gulf Coast Regional Structural Features	12-11
12-6	Geologic Map	12-15
12-7	Drainage Map	12-17
12-8	Lineament Map	12-21
12-9	Field Investigation Plan	12-25
12-10	Well Locations and Seismic Line Data Utilized in Analysis	12-27
12-11	Type Geophysical Log	12-37
12-12	Structural Features	12-45
12-13	Structure Contour Map - Top of Lower Tuscaloosa Formation	12-53
12-14	Structure Contour Map - Top of Selma Group	12-55
12-15	Structure Contour Map - Top of Porters Creek Formation	12-59
12-16	Structure Contour Map - Top of Wilcox Group	12-61
12-17	Structure Contour Map - Top of Kosciusko (Sparta) Formation	12-65
12-18	Structure Contour Map - Top of Cook Mountain Formation	12-67
12-19	Structure Contour Map - Top of Moodys Branch Formation	12-69
12-20	Structure Contour Map - Top of Vicksburg Limestones	12-71

VOLUME VI
LIST OF FIGURES (Continued)

Figure No.	Title	Page
12-21	Isopach Map of Wilcox Group	12-73
12-22	Isopach Map of Cook Mountain Formation	12-75
12-23	Hub Field Structure Map - Top of Lower Tuscaloosa Formation	12-85
12-24	Baxterville Field Structure Map - Top of Davis Sand Member, Lower Tuscaloosa Formation	12-86
12-25	Seismic Section A-A'	12-89
12-26	Seismic Section B-B'	12-91
12-27	Seismic Section C-C'	12-93
12-28	Seismic Section D-D'	12-95
12-29	Seismic Section E-E'	12-97
12-30	Seismic Section F-F'	12-99
12-31	Regional Epicenter Location Map	12-133
12-32	Earthquake Return Period and Probability of Exceedance Curves	12-139
12-33	Oil and Gas Fields	12-141
12-34	Mississippi Oil and Gas Production	12-143

CHAPTER 13

Figure No.	Title	Page
13-1	Topographic Map with Structure Contours on Salt	13-3
13-2	Data Utilized in Analysis	13-5
13-3	Well Location Map	13-7
13-4	Structure Contour Map of Top of Caprock	13-8
13-5	Location Map - Geologic Sections G-G' and H-H'	13-9
13-6	True Scale Dome Section G-G'	13-11
13-7	Geologic Section H-H'	13-13

VOLUME VI
LIST OF FIGURES (Continued)

Figure No.	Title	Page
13-8	Location Map - High-Resolution Seismic Sections J-J', K-K', and L-L'	13-17
13-9	High-Resolution Seismic Cross Section J-J'	13-18
13-10	High-Resolution Seismic Cross Section K-K'	13-19
13-11	High-Resolution Seismic Cross Section L-L'	13-21
13-12	Geologic Map	13-23
13-13	Three-Dimensional Topographic Projection	13-26
13-14	Drainage Network	13-29
13-15	Isolines of Exterior/Interior Drainage Link Frequency	13-31
13-16	Isolines of Drainage Ratio	13-33
13-17	Lineament Map	13-37
13-18	Location Map - Shallow Geologic Sections M-M', N-N', and O-O'	13-41
13-19	Shallow Geologic Section M-M'	13-44
13-20	Shallow Geologic Section N-N'	13-45
13-21	Shallow Geologic Section O-O'	13-46
13-22	Structure Contour Map - Top of Hattiesburg Formation	13-47
13-23	Topographic Map with Structure Contours on Salt	13-61
13-24	Data Utilized in Analysis	13-63
13-25	Well Location Map Showing Available Area	13-65
13-26	Structure Contour Map of Top of Caprock	13-66
13-27	Location Map - Geologic Sections P-P' and Q-Q'	13-67
13-28	True-Scale Dome Section P-P'	13-69

VOLUME VI
LIST OF FIGURES (Continued)

Figure No.	Title	Page
13-29	Geologic Section Q-Q'	13-71
13-30	Location Map - Geologic Section R-R'	13-73
13-31	Geologic Section R-R'	13-75
13-32	Three-Dimensional Topographic Projection	13-79
13-33	Drainage Network	13-81
13-34	Isolines of Exterior/Interior Drainage Link Frequency	13-85
13-35	Isolines of Drainage Ratio	13-87
13-36	Lineament Map	13-89
13-37	Topographic Map with Structure Contours on Salt	13-99
13-38	Data Utilized in Analysis	13-101
13-39	Well Location Map Showing Available Area	13-103
13-40	Structure Contour Map of Top of Caprock	13-105
13-41	Location Map - Geologic Section S-S' and T-T'	13-107
13-42	True-Scale Dome Section S-S'	13-109
13-43	Geologic Section T-T'	13-111
13-44	Location Map - Geologic Section U-U'	13-113
13-45	Geologic Section U-U'	13-115
13-46	Location Map - High Resolution Seismic Sections V-V', W-W', and X-X'	13-119
13-47	High-Resolution Seismic Section V-V'	13-120
13-48	High-Resolution Seismic Section W-W'	13-121
13-49	High-Resolution Seismic Section X-X'	13-122
13-50	Three-Dimensional Topographic Projection	13-123

VOLUME VI
LIST OF FIGURES (Continued)

Figure No.	Title	Page
13-51	Drainage Network	13-127
13-52	Isolines of Exterior/Interior Drainage Link Frequency	13-129
13-53	Isolines of Drainage Ratio	13-131
13-54	Geologic Map	13-133
13-55	Lineament Map	13-137
13-56	Location Map - Shallow Geologic Sections Y-Y', Z-Z', AA-AA',BB-BB'	13-143
13-57	Shallow Geologic Section Y-Y'	13-151
13-58	Shallow Geologic Section Z-Z'	13-153
13-59	Shallow Geologic Section AA-AA'	13-155
13-60	Shallow Geologic Section BB-BB'	13-157
13-61	Structure Contour Map - Top of Hattiesburg Formation	13-159

CHAPTER 14

Figure No.	Title	Page
14-1	Location and Extent of Study Area Relative to Pascagoula and Pearl River Watersheds	14-3
14-2	Regional Drainage Showing Location of Hydrologic Data-Collection Sites	14-5
14-3	Outcrop Map for Selected Hydrogeologic Units	14-15
14-4	Generalized Hydrogeologic Cross-Section	14-19
14-5	Base of Fresh Water Map	14-21
14-6	Top of Very Saline-Water Map	14-25
14-7	Generalized Water Table Map	14-29
14-8	Fresh Water and Environmental Water Heads along Cross Section A-A' through Richton and Cypress Creek Domes	14-32

VOLUME VI
LIST OF FIGURES (Continued)

Figure No.	Title	Page
14-9	Temperature and Density Distribution along Cross Section A-A' through Richton and Cypress Creek Domes	14-34
14-10	Chemical Variations for Ground Water in Deposits of Miocene and Younger Age	14-37
14-11	Chemical Variations for Ground Water in Deposits Older than Miocene Age	14-41
14-12	Location of Waste Disposal Wells and Selected High-Capacity Water Supply Wells	14-45
14-13	Topography and Drainage in Vicinity of Richton Dome	14-84
14-14	Richton Domal Location Showing Area Inundated by Probable Maximum Flooding	14-87
14-15	Hydrogeologic Cross Section Through Richton Dome	14-91
14-16	Water Table in Vicinity of Richton Dome	14-96
14-17	Relation of Travel Time Along a Vertical Flow Path to Depth at Candidate Domes	14-100
14-18	Topography and Drainage in Vicinity of Cypress Creek Dome	14-106
14-19	Cypress Creek Domal Location Showing Area Inundated by Probable Maximum Flooding	14-108
14-20	Hydrogeologic Cross-section Through Cypress Creek Dome	14-109
14-21	Water Table in Vicinity of Cypress Creek Dome	14-114
14-22	Topography and Drainage in Vicinity of Lampton Dome	14-123
14-23	Lampton Domal Location Showing Area Inundated by Probable Maximum Flooding	14-126
14-24	Hydrogeologic Cross Section Through Lampton Dome	14-129

GLOSSARY OF GEOLOGICAL TERMS

AGGRADATION - process of building up a surface by deposition.

ALLUVIUM - a general term for clay, silt, sand, gravel or similar unconsolidated detrital material deposited during comparatively recent geologic time by a stream or other body of running water; adj. alluvial.

ANGULAR UNCONFORMITY - an unconformity in which the younger overlying sediments rest upon the eroded surface of tilted or folded older rocks.

ANHEDRAL - a crystal in which the crystal faces are neither distinct nor characteristic of the particular mineral or element.

ANHYDRITE - a mineral consisting of anhydrous calcium sulfate: $CaSO_4$.

ANHYDROUS - a substance that is completely or essentially without water; an anhydrous mineral contains no water in chemical combination.

ANTICLINE - a fold, the core of which contains stratigraphically older rocks; it is convex upward; adj. anticlinal; ant. syncline.

AQUICLUDE - a body of relatively impermeable rock that is capable of absorbing water slowly but functions as an upper or lower boundary of an aquifer, and does not transmit water rapidly enough to supply a well or spring; "confining bed" is preferred.

AQUIFER - a body of rock that contains sufficiently saturated permeable material to yield significant quantities of water to wells and springs.

AQUIFUGE - an impermeable body of rock; "confining bed" is preferred.

AQUITARD - a body of impermeable material stratigraphically adjacent to one or more aquifers; "confining bed" is preferred.

AREAL MAP - a geologic map showing the horizontal extent and distribution of rock varieties or rock units exposed at the surface.

ARENACEOUS - sediment or sedimentary rock consisting entirely or partially of sand-size fragments, or having a sandy texture or the appearance of sand.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

ARGILLACEOUS - sediment or sedimentary rock consisting entirely or in part of clay-size particles or clay minerals.

ASPHALTIC ROCK - a porous rock that has been impregnated naturally with asphalt.

BENTONITE - a general term for the montmorillonitic clay minerals derived from volcanic ash.

BIOSPHERE - all the area occupied by or favorable for occupation by living organisms including parts of the lithosphere, hydrosphere, and atmosphere. For considerations related to salt dome hydrology, the scope of the biosphere is expanded to include man and his food chain, i.e., from drillable depths, ±9,144 meters (± 30,000 ft) deep in the earth's crust, to the base of the stratosphere.

BIOSTRATIGRAPHY - stratigraphy based on the paleontologic aspects of rocks or stratigraphy with paleontologic methods.

BITTERNS - a natural solution, in an evaporite basin, that resembles a saltworks liquor, especially in its high magnesium content.

BLOCK FAULTING - a type of normal faulting in which the crust is divided into structural or fault blocks of different elevations and orientations.

BLOWOUTS - gaseous outbursts that may occur within a salt mine at the time of blasting and are confined to anomalous zones.

BOUDINAGE - a structure in which an original, continuous, competent layer or bed between less competent layers has stretched, thinned, and broken at regular intervals into bodies resembling boudins (sausage links) elongated parallel to the fold axis.

BOUGUER ANOMALY - a gravity anomaly calculated by allowing for the attraction effect of topography but not for that of isostatic compensation.

BOUNDARY SHEAR ZONES - a zone that forms the boundary between a spine of salt and the outside of the salt dome, or between two spines.

BRECCIATED - said of a rock structure marked by an accumulation of angular fragments, or of an ore texture showing mineral fragments without notable rounding.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

BRINE WELL - a salt well from which water is taken to be evaporated for making salt.

CALCITE - a common rock-forming mineral: $CaCO_3$.

CALIPER LOG - a graphic record which shows, to scale, the diameter of a drilled hole.

CAPABLE FAULT - a fault on which movement at or near the ground surface has occurred at least once within the past 35,000 years, or has had movement of a recurring nature within the past 500,000 years; a fault which has been directly correlated with seismic events.

CAPROCK - a hard rock layer, usually anhydrite, calcite, and gypsum, commonly found overlying the salt stock.

CARBONATE - a sediment formed by the organic or inorganic precipitation from aqueous solution of carbonates of calcium, magnesium or iron.

CARBONIC ACID - A weak naturally occurring acid (H_2CO_3), formed from atmospheric water and carbon dioxide.

CATACLASIS - rock deformation accomplished by fracture and rotation of mineral grains or aggregates without chemical reconstitution.

CLASTIC - a rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals and have been transported individually.

COMMON DEPTH POINT - a point at depth at which seismic reflections are produced at different offset distances on several profiles.

COMPETENT - said of a bed or stratum that is able to withstand the pressures of folding without flowage or change in original thickness.

COMPRESSIVE STRENGTH - a material's resistance to the maximum compressive stress that can be applied to a material, under given conditions, before failure occurs.

CONDUCTANCE - a measurement of salinity or salt (electrolyte) concentration of a fluid.

CONDUCTIVITY - usually refers to electricity or ionic transfer as in an electrolyte; or thermal conductivity, transfer of heat.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

CONFINING BED - a zone or bed of impermeable or distinctly less permeable material adjacent to one or more aquifers; see aquitard.

CONFORMABLE - an unbroken sequence of strata in which the layers are formed one above the other in parallel order by regular uninterrupted deposition under the same general conditions.

CONTOUR MAPS - an illustration of the form and distribution of various types of data produced by joining points of equal value; e.g., structural, isopach, topographic.

COQUINA ROCK- a detrital limestone composed wholly or chiefly of mechanically sorted fossil debris; adj. coquinoid.

CORE - a cylindrical or columnar piece of solid rock or section of soil taken as a sample of an underground formation by a special hollow-type drill bit.

CREEP - slow deformation of solid rock resulting from a small, constant stress acting over a long period of time.

CUESTA - a hill or ridge with a gentle slope (dip slope) on one side and a steep slope (scarp face) on the other.

DECLIVITY - a descending slope.

DEGRADATION - the general lowering of the surface of the land by erosive processes.

DELTA - an alluvial deposit, usually triangular, at the mouth of a river.

DENDRITIC DRAINAGE PATTERN - drainage pattern characterized by irregular branching.

DENUDATION - the process of exposing strata by erosion of overlying materials.

DEPOCENTER - an area or site of maximum deposition.

DESOMANTICLINE - a series of structural highs and lows aligned along a linear axis, resembling a chain or string of beads.

DETRITUS - a collective term for loose rock and mineral material that is worn from an older rock by mechanical means and moved from its place of origin.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

DIAGENESIS - The process by which all the chemical, physical, and biologic changes, modifications or transformations are undergone by a sediment after its initial deposition, and during and after its lithification, exclusive of surficial alteration and metamorphism.

DIAPIR - a dome or anticlinal fold, the overlying rocks of which have been ruptured or pierced by the squeezing out of the plastic core material, such as salt or an incompetant shale.

DIAPIRISM - the process of piercing or rupturing of domes or uplifting overlying rocks by core material, such as salt.

DIP - the angle that a bedding or structural surface makes with the horizontal plane, measured perpendicular to the strike.

DISCONFORMITY - an unconformity in which the older rocks remained essentially horizontal during erosion or cessation of deposition during simple vertical rising and sinking of the crust.

DISSOLUTION - a space or cavity in or between rocks formed by the solution of part of the rock material.

DOME - see salt dome.

DOWNCUTTING - stream erosion in which the cutting is directed in a downward direction.

DOWNDIP - a direction that is downwards and parallel to the dip of a structural surface.

DOWN-HOLE GEOPHYSICAL LOGGING - the process of lowering an instrument into a borehole or well and recording continuously on a meter at the surface some physical property of the rock material being logged.

DRAG FOLDS - minor folds that form in an incompetent bed when the competent beds on either side of it move in such a way as to subject it to a couple; any fold that is a subsidiary part of a larger fold.

EARTHQUAKE INTENSITY/ACCELERATION - a measure of the effects of an earthquake at a particular place on humans and/or structures.

ENTRENCHMENT - the process of a stream eroding downward so as to form a trench.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

EPICENTER - the point on the Earth's surface which is directly above the focus of an earthquake.

EPICENTRAL INTENSITY - a measure of an earthquake's intensity at its epicenter.

EQUIDIMENSIONAL - a textural term describing a material in which all crystals or grains are essentially the same size.

ESCARPMENT - a long, more or less continuous cliff or relatively steep slope facing in one general direction, breaking the general continuity of the land by separating two level or gently sloping surfaces.

EUHEDRAL - a crystal in which the crystal faces are very distinct and characteristic of the particular mineral or element.

EUSTATIC - pertaining to worldwide changes of sea level that affect all of the oceans.

EVAPORITE - a nonclastic sedimentary rock composed primarily of minerals precipitated from a saline solution.

EXFOLIATION - the process by which thin concentric shells are successively broken loose from the bare outer surface of a large rock mass.

EXTERNAL SHEATH ZONE - a zone that forms the boundary between a spine of salt and the outside of the salt dome type of boundary shear zone.

EXTRUSION - the igneous process of emitting lava onto the Earth's surface; also, the rock so formed.

FACIES - the sum of all primary lithologic and paleontologic characteristics exhibited by a sedimentary rock and from which its origin and environment of formation may be inferred; the general aspect, nature or appearance of a sedimentary rock produced under or affected by similar conditions.

FAULT - a surface or zone of rock fracture along which there has been displacement.

FERRUGINOUS - pertaining to or containing iron.

FIRST ORDER LEVELING - spirit leveling to establish a horizontal line of sight of high precision and accuracy.

FISSILE - capable of being easily split along closely spaced planes.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

FLAGGY ROCK - rock that tends to split into layers 1 to 5 cm (0.39 to 1.96 in) in thickness.

FLEXURE - a fold formed by warping or other gentle deformation rather than by compression; c.f. hinge fault.

FLEXURE FAULT - a fault that originally occurred as a flexure.

FLUVIATILE - pertaining to river flow and river action.

FORMATION - a basic convenient unit of rocks, of considerable thickness and extent, used in mapping, describing, or interpreting the geology of a region, and the only formal classification that is used for completely dividing the whole geologic column all over the world into named units on the basis of lithology.

FORMATION PACKER - a drill-stem testing apparatus utilized in boreholes to isolate a particular zone of interest in the rock section by inflating flexible steel-meshed rubber cushions against the sides of the hole, thus permitting formation fluids to be sampled.

FRACTURE - general term for any break or separation in a rock.

FRIABILITY - the ease with which a material can be crumbled.

GEOHYDROLOGY - a term referring to the flow characteristics of subsurface waters; c.f. ground-water hydrology.

GEOID - the "figure of the Earth" considered as a sea level surface extended continuously through the continents.

GEOLOGIC OR STRATIGRAPHIC CROSS SECTIONS - a diagram that shows geologic features transected by a given plane (usually a vertical plane).

GEOLOGIC STRUCTURE - the general disposition, attitude, arrangement, or relative positions of the rock masses of a region or area; the sum total of the structural features of an area; also used to designate any physical arrangement of rocks, such as an anticline or fault, due to earth forces.

GEOMORPHOLOGY - the science that treats the general configuration of the Earth's surface and its relationship to geologic forces. The interpretative study of landforms; see physiography.

GEOPHYSICAL LOGS - a log obtained by lowering an instrument into a borehole or well, while recording continuously on a meter at the surface some physical property of the rocks through which it passes.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

GEOPRESSURED - subsurface condition in which the fluid pressures exceed the normal hydrostatic pressures, due generally to the weight of the overburden.

GEOSYNCLINE - a mobile downwarping of the crust of the Earth, measured in scores of kilometers, which is subsiding as sedimentary and volcanic rocks accumulate to a thickness of thousands of meters; adj. geosynclinal.

GLACIO-ISOSTASY - the state of hydrostatic equilibrium in the Earth's crust as influenced by the weight of glacial ice.

GLAUCONITE - a dull green, amorphous, and earthy or granular mineral of the mica group.

GOUGE - a thin layer of soft rock material between a salt plug and adjacent strata created by cataclasis during diapirism.

GRABEN - an elongated, relatively depressed crustal unit or block that is bounded by faults along its sides; down-dropped fault block; c.f. horst.

GRAIN DENSITY - specific gravity of the grains composing a sediment or sedimentary rock.

GROUND WATER - that part of the subsurface water which is in the zone of saturation.

GROUP - a major rock-stratigraphic unit, next higher in rank than formation; consisting wholly of two or more contiguous or associated formations having significant lithologic features in common.

GROWTH FAULT - a fault in sedimentary rocks that forms contemporaneously and continuously with deposition.

GYPSUM - a mineral consisting of hydrous calcium sulfate: $CaSO_4 . 2H_2O$.

HALITE - native salt; the mineral sodium chloride: NaCl.

HALOKINETICS - a general term for the study of the structure and mechanism of salt movements.

HALO-TECTONIC - pertaining to the forces resulting in salt movement.

HECTARE - a metric unit of land area equal to 10,000 square meters or 2.471 acres.

HEMATITE - a common iron mineral consisting of ferrous oxide: Fe_2O_3.

HIATUS - a break or interruption in the continuity of the geologic record.

HINTERLAND - an area bordering, or within, an orogenic belt on the internal side, away from the direction of overfolding and thrusting.

HOMOCLINAL SHEAR ZONES - a tabular zone of rock that has been brecciated by parallel fracture along rock units which have the same dip.

HOMOGENEOUS SEISMICITY - seismic activity equally dispersed throughout its occurrence.

HORST - an elongated, relatively uplifted crustal unit or block that is bounded by faults on its long sides; uplifted fault block.

HOST ROCK - a body of rock which includes relatively small amounts of other rocks or mineral deposits.

HYDROGEOLOGY - the science that deals with subsurface waters and related geologic aspects of surface waters.

HYDROLOGY - the science that deals with continental water, its properties, circulation, and distribution on and under the Earth's surface and in the atmosphere.

IGNEOUS - said of a rock or mineral that solidified from a molten or partially molten state, i.e. from a magma; contrasted to sedimentary.

INDURATED - condition of a compact rock or soil hardened by the action of pressure, cementation, or especially heat.

INLIER - an area or exposed group of rocks surrounded by outcrops of younger rocks.

INTENSITY RECURRENCE FUNCTION - a statistically determined relationship expressing the probabilistic likelihood of experiencing a certain [earthquake] intensity as a function of time.

INTERFLUVES - the areas between rivers; esp. the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction and belonging to the same general drainage basin or watershed.

INTERGLACIAL - pertaining to the time interval between two successive glacial epochs, or between two glacial stages.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

INTERNAL BOUNDARY ZONE - a zone which forms the boundary between two salt spines.

INUNDATED - to be covered with water; flooded.

ISOCHORE - a line drawn through equal interval between two beds or other places.

ISOCHORE MAP - a map that shows the varying interval between two designated stratigraphic planes or horizons, possibly including one or more unconformities. c.f. isopach map.

ISOCLINAL FOLDS - a fold in which the limbs have been so compressed that they have the same dip.

ISOPACH - a line drawn on a map through points of equal thickness of a designated stratigraphic unit.

ISOPACH MAP - a map that shows the thickness of a designated stratigraphic unit; c.f. isochore map.

ISOSEISMAL - a line connecting points on the Earth's surface at which earthquake intensity is the same.

ISOSTASY - the condition of equilibrium [comparable to floating] of the units of the brittle crust above the denser plastic mantle. Principle of equilibrium level between coastal segments of equal area having same mass.

ISOSTATIC (SEA LEVEL CHANGES) - changes in sea level resulting from adjustments in the Earth's crust to maintain equilibrium among units of varying mass and density.

JUVENILE WATER - term applied to water that is known to be derived directly from magma and comes from the Earth's interior to the surface for the first time.

KAOLINITE - a common, white to grayish or yellowish clay mineral of the kaolin group: $Al_2 Si_2 O_5 (OH)_4$.

KNICKPOINT - a point of abrupt change in the longitudinal profile of stream valleys.

LENS - a geologic deposit bounded by converging surfaces, thick in the middle and thinning toward the edges.

LENTIL - a minor rock stratigraphic unit of limited geographic extent, being a subdivision of a formation and similar in rank to a member, and thinning out in all directions.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

LEVELING - the operation of determining the comparative altitude of different points on the Earth's surface.

LIGNITE - a brownish-black coal that is intermediate in coalification between peat and subbituminous coal.

LIMESTONE - a class of rock which is composed of at least 80 percent of calcium or magnesium carbonates.

LIMONITE - a general term for a group of brown, amorphous, naturally occurring hydrous ferric oxides not specifically identified.

LINEAMENT - an alignment of surficial features that is structurally controlled, such as stream beds, vegetation or soil or rock tone that are so controlled; commonly observed on aerial photos or topographic maps.

LINEAR - a straight or gently curved physiograhic feature on the Earth's surface.

LINEATION - a general term for any linear feature of whatever scale in a rock.

LITHOLOGY - the physical description of rocks on the basis of such characteristics as color, mineralogic composition, and grain size.

LITHOSPHERE - the solid portion of the earth, as compared with the atmosphere and hydrosphere.

LUTITE - sediment or sedimentary rock consisting principally of clay or clay-sized particles.

MARL - an old term loosely applied to a variety of materials, most of which occur as soft, loose, earthy, and semifriable or crumbling unconsolidated deposits consisting chiefly of an intimate mixture of clay and calcium carbonate in varying proportions, formed under either marine or fresh-water conditions.

MASSIFS - an embryonic salt dome rising from its source bed, still at depth.

MICRITE - a limestone with a very fine subcrystalline texture.

MODIFIED MERCALLI INTENSITY - scale (from I to XII) for evaluating earthquake shocks.

METAMORPHIC - any rock derived from preexisting rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, etc.

MHO - a unit of electical conductance equal to the reciprocal of ohm.

MICROFOSSIL - a fossil too small to be studied without the aid of a microscope.

MICROMHO - mho x 10^{-6}.

MICROCRYSTALLINE - said of the texture of a rock consisting of or having crystals that are small enough to be visible only under a microscope; also said of a rock having such a texture.

MICROSEISMIC MONITORING - earthquake measurement or observation by instrumental means of shocks below the sensitivity threshold of the conventional seismograph.

MINERALOGY - the study of minerals, their formation and occurrence, their properties and composition, and their classification.

NEOGENE - an informal usage for the period of time incorporating the Miocene and Pliocene of the Tertiary Period.

NERITIC - pertaining to the ocean environment or depth zone between low-tide level and 100 fathoms, or between low-tide level and approximately the edge of the continental shelf.

NONCONFORMITY - an unconformable contact between sedimentary rocks lying upon an eroded surface of older igneous or metamorphic rocks.

NORMAL FAULT - a fault in which the hanging (upper) wall appears to have moved downward relative to the footwall. The angle of the fault is usually 45-90°.

OFFLAP - the reverse of transgressive onlap, occurring where a shoreline has retreated seaward and progressively younger strata have been deposited in layers offset seaward; a type of overlap.

ONLAP - extension of successive stratigraphic units beyond the marginal limits of their predecessors onto older rocks as in the deposits of a trangressing sea; a type of overlap.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

OOLITHS - one of the small, round accretionary bodies in a sedimentary rock, usually calcium carbonate.

OOLITE - a sedimentary rock usually a limestone, made up chiefly of ooliths cemented to others.

OOLITIC LIMESTONE - an even textured limestone composed almost entirely of relatively uniform calcareous ooliths.

OROGENIC BELT - a linear region that has been subjected to folding and deformation during an orogenic cycle.

OROGENY - the process by which rock structures in mountainous areas were formed.

OUTLIER - an area or group of rocks surrounded by outcrops of older rocks.

OVERBURDEN - the loose soil, silt, sand, gravel or other unconsolidated material overlying bedrock.

OVERCONSOLIDATION - consolidation resulting from desiccation or from pressure of overburden that has since been removed by erosion.

OXBOW LAKE - the crescent-shaped body of standing water situated by the side of a stream in the abandoned channel (oxbow) after the stream formed a neck cutoff and the ends of the original bend were silted up.

PALEOGENE - an informal usage for the interval of geologic time incorporating the Paleocene, Eocene, and Oligocene of the Tertiary Period.

PALEOGEOGRAPHIC MAP - a map that shows the reconstructed physical geography at a particular time in the geologic past.

PALEONTOLOGY - the study of life in past geologic periods, based on fossil plants and animals and including phylogeny, their relationships to existing plants and animals, and the chronology of the Earth's history.

PELLET - a small, usually rounded, aggregate of accretionary material; also fecal matter from fossil organisms.

PELLETAL LIMESTONE - a limestone characterized by abundant pellets.

PENCIL - long, slender pieces of rock (anhydrite) resembling pencils.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

PENEPLAIN - a low, nearly featureless and gently undulating or almost-plane land surface of considerable area.

PERMEABILITY - the property or capacity of porous rock, sediment, or soil for transmitting a fluid without impairment of the structure of the medium.

PETROFABRIC - the textural features of a rock.

PETROLOGY - that branch of geology dealing with the origin, occurrence, structure and history of rocks, especially igneous and metamorphic rocks.

PETROGRAPHY - the branch of geology dealing with the description and classification of rocks, especially igneous and metamorphic rocks.

PHYSIOGRAPHY - the descriptive study of landforms; see geomorphology.

PIERCEMENT DOME - see diapir.

PIERCEMENT STAGE - a stage of salt dome development in which the salt rises vertically, penetrating the overlying strata.

PIEZOMETRIC SURFACE - see potentiometric surface.

PILLOWING - a stage of salt dome development in which the salt is said to move laterally into mounds or "pillows."

PINCH-OUT - the termination or end of a stratum, vein, or other body or rock by tapering or progressively narrowing to extinction.

PLASTICITY - the property of a material that enables it to undergo permanent deformation without appreciable volume change or elastic rebound, and without rupture.

POTASH - potassium carbonate, K_2CO_3.

POROSITY - the property of a rock, soil, or other material containing interstices, and the ratio of the volume of its interstices to its total volume.

POTENTIOMETRIC SURFACE - an imaginary surface representing the static head of ground water and defined by the level to which water will rise in a well; c.f. piezometric surface.

PRODELTA - that part of the delta that is below the effective depth of wave erosion, lying beyond one delta front and sloping gently down to the floor of one basin into which the delta is advancing.

PROLATE - designating the shape of a solid, especially of a spheroid having its polar axis longer than its equatorial diameter; cigar-shaped.

QUAQUAVERSAL DIP - dipping outward in all directions from a central point, as a dome in stratified rocks.

RADIONUCLIDE - a radioactive species of atom characterized by the number of neutrons and protons in its nucleus; a product of radioactivity.

REDBEDS - sedimentary strata composed largely of clastic materials that are predominantly red in color due to the presence of hematite.

RELICT - a relief feature or rock remaining after other parts have disappeard.

REMOTE SENSING - in a restricted sense the practice of data collection in the wavelengths from ultraviolet to radio regions; a practical outgrowth of airborne photography.

RESIDUAL GRAVITY - the difference between theoretical, calculated, and observed terrestrial gravity, measured in milligals.

RESISTIVITY - the resistance to electrical current of a rock unit, measured instrumentally as a reconnaissance method of determining the nature of rocks in the shallow subsurface.

RIFT - a narrow cleft, fissure, or other opening in rock made by cracking or splitting; a large strike-slip fault parallel to regional structures.

RIFT BASIN - a deep central cleft in the crest of a mid-oceanic ridge.

RIFT VALLEY - valley produced by subsidence of a block bounded by two rifts.

RIM SYNCLINES - downfolds that tend to develop around the periphery of salt domes due to sagging of the overlying strata into a circular void created by the removal of salt from the source strata.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

SALINE - a natural deposit of common salt or of any other soluble salt, e.g., an evaporite; pertaining to, consisting of, or containing salt; refers also to various features related to a natural evaporitic environment, e.g., playa, salt lake, salt pan, etc.

SALT CORE - a cylindrical sample of salt obtained by drilling into a rock salt body with a hollow drill bit; also, the central portion of salt stock.

SALT DOME - a structure resulting from the upward movement of a salt mass.

SALT STOCK - the salt mass portion of a salt dome structure.

SANDSTONE - a cemented or otherwise compacted detrital sediment composed predominantly of quartz grains.

SEDIMENTARY ROCK - a rock resulting from the consolidation of loose sediment that has accumulated in layers.

SEISMIC - pertaining to an earthquake or Earth vibration, including those that are artificially produced.

SEISMICITY - the phenomenon of Earth movements.

SEISMIC REFLECTION - a geophysical technique which measures the time of energy from a seismic source which has been reflected.

SEISMIC SURVEY - the gathering of data from artificially induced vibrations.

SEISMOLOGY - the study of earthquakes; by extending the study of the structure of the interior of the Earth via both natural and artificially generated seismic signals.

SEISMOTECTONIC REGION - a region characterized by a relative consistency of historical seismicity and of structural activity among geologic features contained therein.

SERIES - a time-stratigraphic unit generally classed next in rank below a system, and above a stage, properly based on a clearly designated stratigraphic interval in a type area.

SHEAR - strain resulting from compressive stresses that cause or tend to cause contiguous parts of a body to slide relative to each other in a direction parallel to their plane of contact; usually at an angle other than perpendicular to the direction of stress.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

SHALE - a laminated sediment in which the constituent particles are predominantly of the clay grade.

SHEAR MODULUS/S-WAVE VELOCITY -rigidity or shear modulus is a measure of the stress-strain ratio for a simple shear.

SHEAR WAVES - that type of seismic body wave which is propagated by a shearing motion of material so that there is oscillation perpendicular to the direction of propagation.

SHEATH (Lighology)- rock material, commonly shale, which surrounds or encompasses a salt plug.

SHEATH (Struct.)- pertaining to the external zone of a salt stock in which expansion of the salt has taken place, increasing the porosity and permeability.

SIDERITE - a rhombohedral mineral: $FeCO_3$.

SIDETRACKING - the practice of diverting multiple subsurface drill-holes from a single surface drill-hole.

SINKHOLE - a general term for a depression in an area of karst topography that is formed either by the solution of the surficial limestone or by the collapse of underlying caves.

SLABBING/SPALLING (OF WALLS) - the natural process of sloughing of large slabs of salt from the walls of mine workings.

SLOPE STABILITY - the quality of permanence or resistance of a natural or artificial slope to failure by landsliding.

SOLUTION - a process of chemical weathering by which rock material passes into solution.

SONIC LOG - an acoustic log continuously recording travel time of sound from the surface to an instrument lowered down a borehole.

SPALLING - see slabbing/spalling.

SPINE - a vertical protrusion of a salt stock which may or may not move upward at a different rate than the rest of the stock.

STACKING - a statistical method of processing seismic records that has the effect of averaging the intensity of the rays of energy from a single reflection point, while reducing the relative amount of noise or signal interference.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

STALACTITE - a cylindrical or conical deposit of minerals hanging from the roof of a cavern.

STALAGMITE - a column or ridge of material rising from the floor of a cavern or mine, caused by water dripping down from above.

STRADDLE-PACKER - a drill-stem testing apparatus utilized in boreholes to isolate a zone or interval of interest in the rock section (see formation packer).

STRATIGRAPHY - the arrangement of strata especially as to geographic position and chronological order of sequence: the branch of geology that deals with the description of minor and major divisions of rock.

STRATUM - a tabular or sheet-like mass, or a single and distinct layer, of monogeneous or gradational sedimentary material, distinguishable from mass above and below.

STREAM REACH - arbitrary lengthwise section of a stream.

STRIKE - the direction or trend of a structural surface with the horizontal plane.

STRUCTURAL GEOLOGY - that branch of geology that deals with the form, arrangement, and internal structure of the rocks.

STRUCTURE - the general disposition, attitude, arrangement, or relative positions of the rock masses of a region or area.

SUBAERIALLY - occurring beneath the atmosphere or in the open air; esp. said of conditions and processes (such as erosion) that exist or operate on or immediately adjacent to the land surface; c.f. - subaqueous.

SUBHEDRAL - a crystal in which the crystal faces are intermediate between distinct and non-distinct.

SYLVITE - a white or colorless isometric mineral, potassium chloride (KCl). It is the principal ore of potassium.

SYNCLINE - a fold, the core of which contains the stratigraphically younger rocks; it is concave upward.

SYNTHETIC SEISMOGRAM - artificial seismogram produced by computer from the acoustic velocity log of a well.

TARRY OIL SEEP - a place of emergence of tar-like petroleum as a result of the slow migration from its buried source, through minute pores or fissures.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

TECTONIC - dealing with the rock structure and external forms resulting from the deformation of the earth's crust; as applied to earthquakes it is used to describe shocks not due to volcanic action or the collapse of caverns or landslides.

TECTONIC STRUCTURE - a large scale dislocation in or distortion of the Earth's crust.

TERRACE - any long, narrow, relatively level, or coastward gently inclined surface bounded on one edge by a steeper descending slope and also along the other by a steeper ascending slope; a large bench or step-like ledge.

TERRIGENOUS - produced from or of the Earth, terrigenous deposits are sediments derived from the land and deposited in shallow marine area.

TERRESTRIAL - pertaining to the land surface of the earth; terrestrial deposits are those made on land, above tidal reach.

THROW - on a fault, the amount of vertical displacement.

TILT - the angle at the perspective center between the plumb line and the perpendicular from the interior perspective center to the plane of a photograph.

TILTMETER - an instrument that measures slight changes in tilt of the Earth's surface.

TUFF - a compacted pyroclastic deposit of volcanic ash and dust that may contain up to 50% sediments such as sand or clay.

TUFFACEOUS MATERIAL - sediment containing up to 50% tuff.

UNCONFORMABLE - strata or stratification exhibiting the relation of unconformity to the older underlying rocks.

UNCONFORMITY - a substantial break or gap in the geologic record where a rock unit is overlain by another that is not next in stratigraphic succession.

UPDIP REGION - a direction which is upwards and parallel to the dip of a structure or surface.

UPLIFT - a structurally high area in the crust produced by positive movements that raise or upthrust the rocks.

VALES - a rift valley or tectonic valley; also land between two parallel cuestas.

GLOSSARY OF GEOLOGICAL TERMS (Continued)

VIRGIN ROCK - fresh rock that has not been weathered.

VOID RATIO - the ratio of the volume of void space to the volume of solid substance in any material consisting of voids and solid material.

VUG - a cavity, often with a mineral lining of different composition from that of the surrounding rock.

WATERSHED - the area contained within a drainage divide above a specified point on a stream.

WOLD - a range of hills produced from differential erosion from inclined sedimentary rocks; a cuesta.

XENOLITH - rock fragments contained in an igneous body of rock which are foreign to the host rock; inclusion.

CONVERSION FACTORS

The conversion factors used in this report are based on the following table. In most instances, the metric-to-standard measurement conversions represent rounded-off figures in this report.

To convert from	To	Multiply by
millimeter (mm)	inch (in)	0.03937
meter (m)	foot (ft)	3.281
kilometer (km)	mile (mi)	0.6214
meter^2 (m^2)	foot^2 (ft^2)	10.76
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
hectare (-)	acre (-)	2.471
kilogram (kg)	pound (lb)	2.205
tonne (-)	ton (-)	0.893
liter (l)	gallon (gal)	0.2642
kilometers^3 (km^3)	miles^3 (mi^3)	0.244
kilopascal (kPa)	atmosphere (atm)	0.009869
milligrams per liter (mg/l)	parts per million (ppm)	1.0
liter per second (l/sec)	gallon per minute (gal/min)	15.85

ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
BEG	Texas Bureau of Economic Geology
BMI	Battelle Memorial Institute
BNI	Bechtel National, Inc.
DOE	Department of Energy
ERTS	Earth Resources Technology Satellite
FEA	Federal Energy Administration
LANDSAT	Earth Resources Technology Satellite (formerly ERTS)
LETCo	Law Engineering Testing Company
LSU/IES	Louisiana State University/Institute for Environmental Studies
MGAI	Mellen Geological Associates, Inc.
MM	Modified Mercalli
MMI	Modified Mercalli Intensity
MSGS	Mississippi State Geological Survey
MSL	Mean Sea Level
NAS	National Academy of Science
NRC	Nuclear Regulatory Commission
NSAI	Netherland, Sewell and Associates, Incorporated
NWTS	National Waste Terminal Storge
ONWI	Office of Nuclear Waste Isolation of Battelle Memorial Institute
ORNL	Oak Ridge National Laboratories
OWI	Office of Waste Isolation/Union Carbide Corp.
SCS	Soil Conservation Service
TAB	Technical Advisory Board
TNRIS	Texas Natural Resource Information System
USGS	United State Geological Survey
USM	University of Southern Mississippi

12 GEOLOGIC CHARACTERIZATION OF THE MISSISSIPPI STUDY AREA

12.1 DESCRIPTION OF THE MISSISSIPPI STUDY AREA

The study area is located in the southeastern portion of the Mississippi Salt Basin within the Gulf Coastal Plain. It encompasses a 3,730-km^2 (1,440-mi^2) area in southeastern Mississippi located between 88° 50' and 89° 50' west longitude and between 31° 05' and 31° 25' north latitude (Figure 12-1). The area measures about 97 km (60 mi) in an east-west direction and 39 km (24 mi) north-south and includes most of Lamar, Forrest, and Perry Counties and the northern and eastern portions of Marion County, Mississippi. Three candidate piercement salt domes, Lampton Dome in east-central Marion County, and Cypress Creek and Richton Domes in southern and northern Perry County, respectively, are characterized in Chapter 13.

Topographically, the area consists of gently rolling hills interrupted by the wide, flat-bottomed valleys of the major regional streams (Figure 12-2). Topographic relief of approximately 91 meters (300 ft) is typically developed by stream dissection on this gently southeasterly sloping portion of the Gulf Coastal Plain. Surface elevations range from about 30 meters (100 ft) above sea level in the stream valleys to about 122 meters (400 ft) on the hills in the interstream areas. Elevations are generally similar to those of the Mississippi Gulf Coastal Plain.

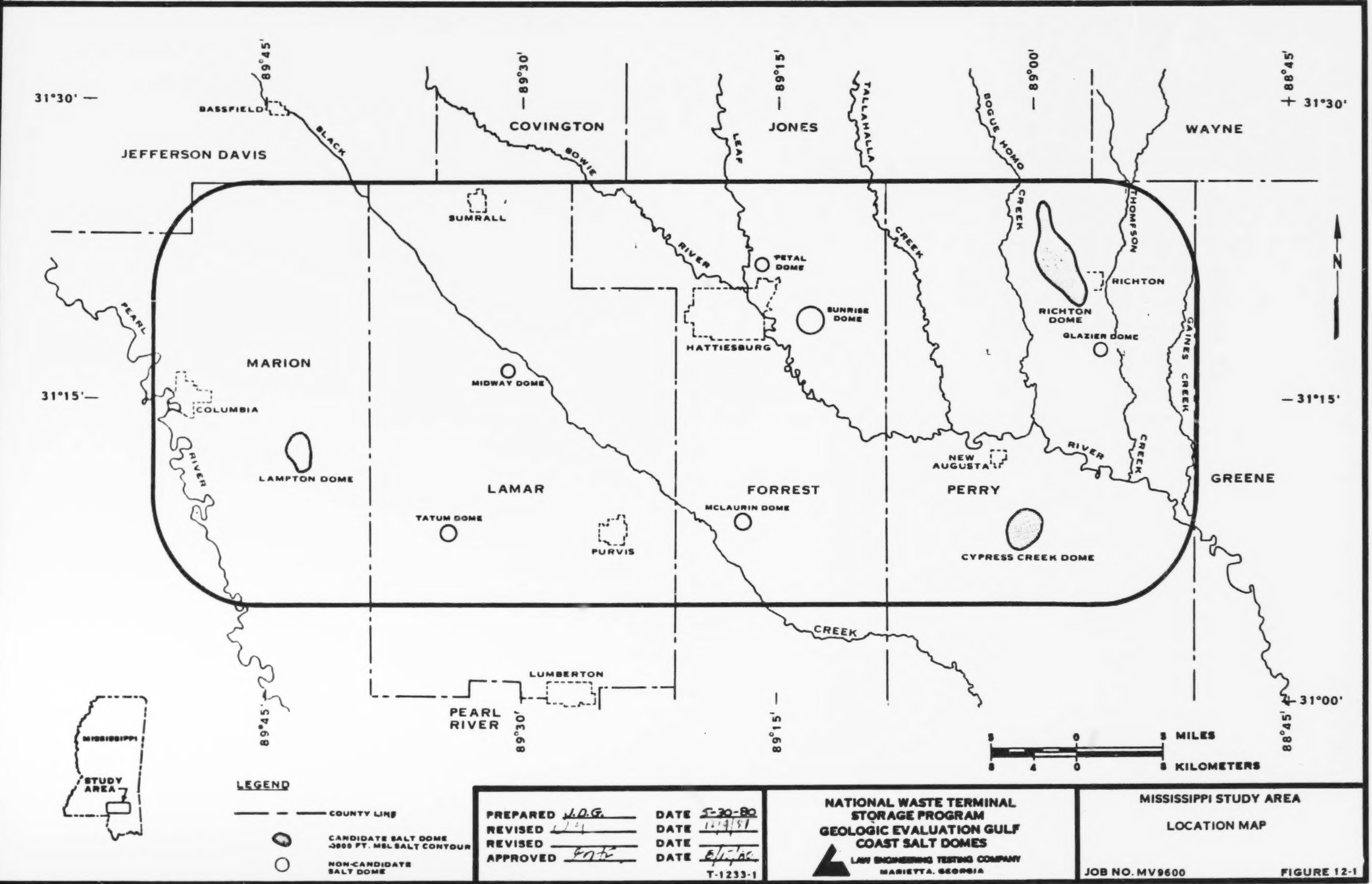
The area is drained by tributaries of both the Pearl and Pascagoula River systems (Figure 14-1). The Pearl River flows across Marion County in the southwestern portion of the study area (Figure 12-1). The Bowie and Leaf Rivers and Black Creek, all major tributaries of the Pascagoula River, flow southeasterly across the study area into the Pascagoula River and to the Gulf. There are few large natural and man-made lakes or reservoirs in the study area.

Industrial and public forests comprise approximately 75 percent of total land usage, with farmlands and pasturelands accounting for the bulk of the remaining areas. The forests are dominantly longleaf and slash pine, although islands of oak, gum and cypress, as well as loblolly and shortleaf pine, also grow in the area. Nearly half of Forrest and Perry Counties are included in the De Soto National Forest.

Population density generally reflects the rural nature of the area. Forrest County, with 124 people per square mile in 1970, is by far the most populous county in the study area. The 1970 population density in the other three counties, listed by people per square mile, are: Marion County, 42; Lamar County, 31; and Perry County, 14 (U.S. Bureau of the Census, 1970). Urban centers in the study area include the cities of Hattiesburg and Petal, with approximate populations of 40,000 and 9,000, respectively, which account for most of the population density in Forrest County, and the city of Columbia, in Marion County, with approximately 7,000 people.

Transportation routes include Interstate Highway 59, a major north-south route, U.S. Routes 49 and 98, and several state routes, nearly all of which pass near or through the city of Hattiesburg (Figure 12-2). Two major Illinois Central Gulf rail

[redacted]


31°30'
31°15'
31°00'
89°45'
89°30'
89°15'
89°00'
88°45'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
PEARL RIVER
BLACK CREEK
BOWIE RIVER
LEAF RIVER
TALLAHALLA CREEK
BOGUE HOMO CREEK
THOMPSON CREEK
GAINES CREEK
PEARL RIVER
SUMRALL
PETAL DOME
SUNRISE DOME
HATTIESBURG
RICHTON
RICHTON DOME
GLAZIER DOME
MIDWAY DOME
COLUMBIA
LAMPTON DOME
TATUM DOME
PURVIS
MCLAURIN DOME
NEW AUGUSTA
CYPRESS CREEK DOME
LUMBERTON
N
5 0 5 MILES
8 4 0 8 KILOMETERS
MISSISSIPPI
STUDY AREA
LEGEND
COUNTY LINE
CANDIDATE SALT DOME -3000 FT. MSL SALT CONTOUR
NON-CANDIDATE SALT DOME

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE 12/[illegible]/81
REVISED DATE
APPROVED [illegible] DATE [illegible]
T-1233-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

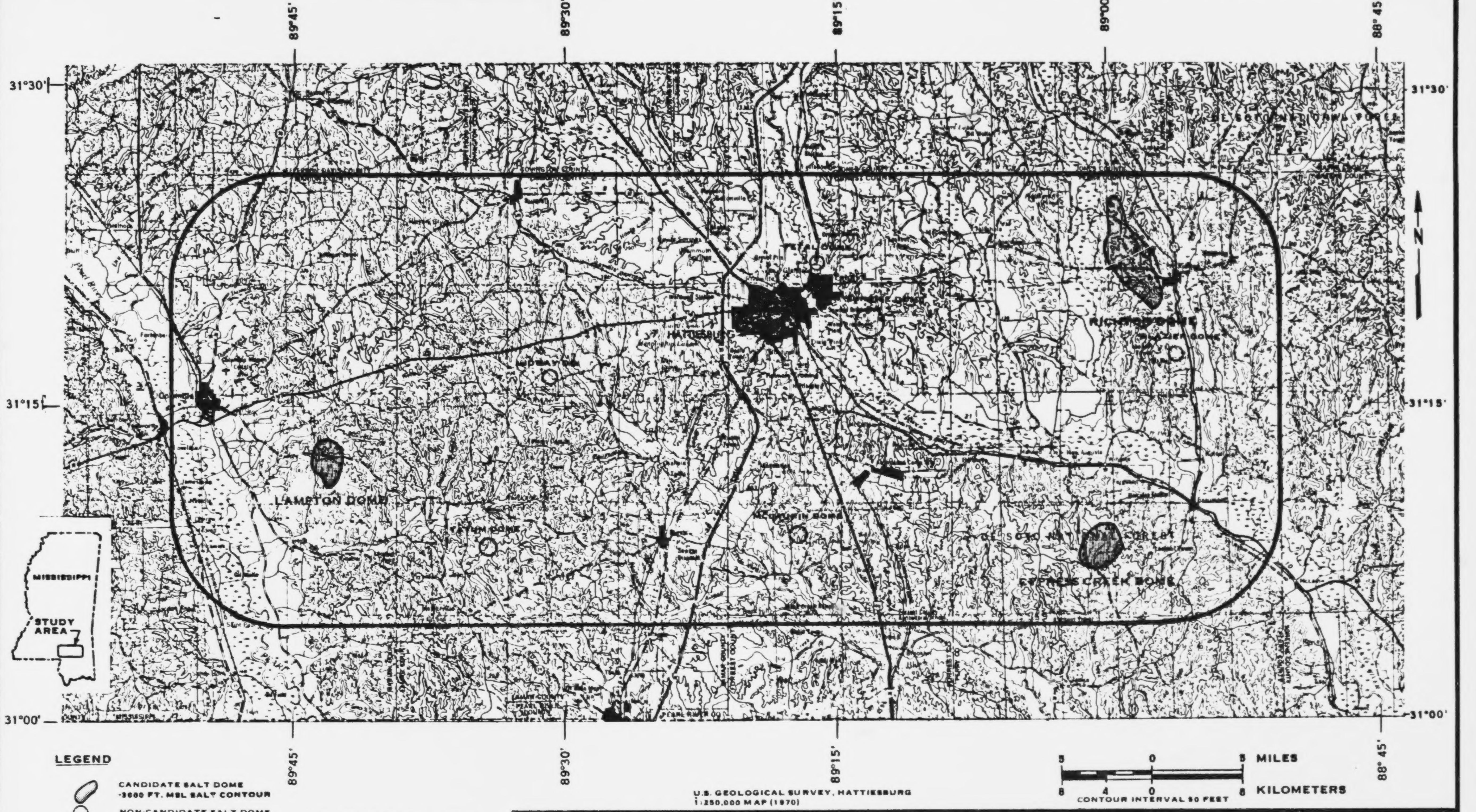
MISSISSIPPI STUDY AREA

LOCATION MAP

JOB NO. MV9600

FIGURE 12-1

BEST DOCUMENT AVAILABLE


89°45'
89°30'
89°15'
89°00'
88° 45'
31°30'
31°15'
31°00'
N
HATTIESBURG
LAMPTON DOME
RICHTON DOME
CYPRESS CREEK DOME
DE SOTO NATIONAL FOREST
MISSISSIPPI
STUDY AREA
5 0 5 MILES
8 4 0 8 KILOMETERS
CONTOUR INTERVAL 50 FEET

U.S. GEOLOGICAL SURVEY, HATTIESBURG
1:250,000 MAP (1970)

LEGEND

⬮	CANDIDATE SALT DOME -3000 FT. MSL SALT CONTOUR
○	NON-CANDIDATE SALT DOME
┼┼┼	RAILROAD
—	ROADS
	ROUTE MARKERS; INTERSTATE, U.S., STATE
283	SPOT ELEVATION IN FEET
▭	MARSH OR SWAMP
~	INTERMITTENT STREAM
— - —	COUNTY LINE
·····	POWER LINE

PREPARED J.D.G. DATE 5-30-80
REVISED D.J DATE 1-13-81
REVISED DATE
APPROVED Porter DATE 8/15/80
T-1234-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

TOPOGRAPHIC MAP

JOB NO. MV9600

FIGURE 12-2

4

BEST DOCUMENT AVAILABLE

lines and a major Southern Railway line cross the study area. Several spur lines also serve the cities of Hattiesburg and Columbia and the town of Richton.

Mineral resource development chiefly involves production of petroleum, natural gas, sand, and gravel. Brick clays, produced in Forrest County, are of lesser importance.

12.2 GEOLOGY OF THE MISSISSIPPI STUDY AREA

The geology of the Mississippi Study Area was characterized by research and by analyses of existing data, as well as data acquired during the study. Six generic topics--physiography, geomorphology, stratigraphy, structure, seismicity, and mineral resources--were selected for data acquisition and analysis. These topics serve as a reliable basis for characterizing the geology of the study area and for comparison with the regional geologic framework of the Gulf Coastal Province. In addition, they serve as a basis for comparison of the near-dome geology to that of the study area.

12.2.1 PHYSIOGRAPHY AND GEOMORPHOLOGY: The Mississippi Study Area lies entirely within the Piney Woods Physiographic Subprovince of the Gulf Coastal Province (Priddy, 1960) (Figure 12-3). The subprovince is a maturely dissected plain sloping gently toward the southeast (Foster and McCutcheon, 1941). Broadly arcuate belts of Cretaceous and Tertiary sedimentary strata, dipping gently to the southwest, characterize the bordering subprovinces north and east of the Piney Woods Subprovince (Figure

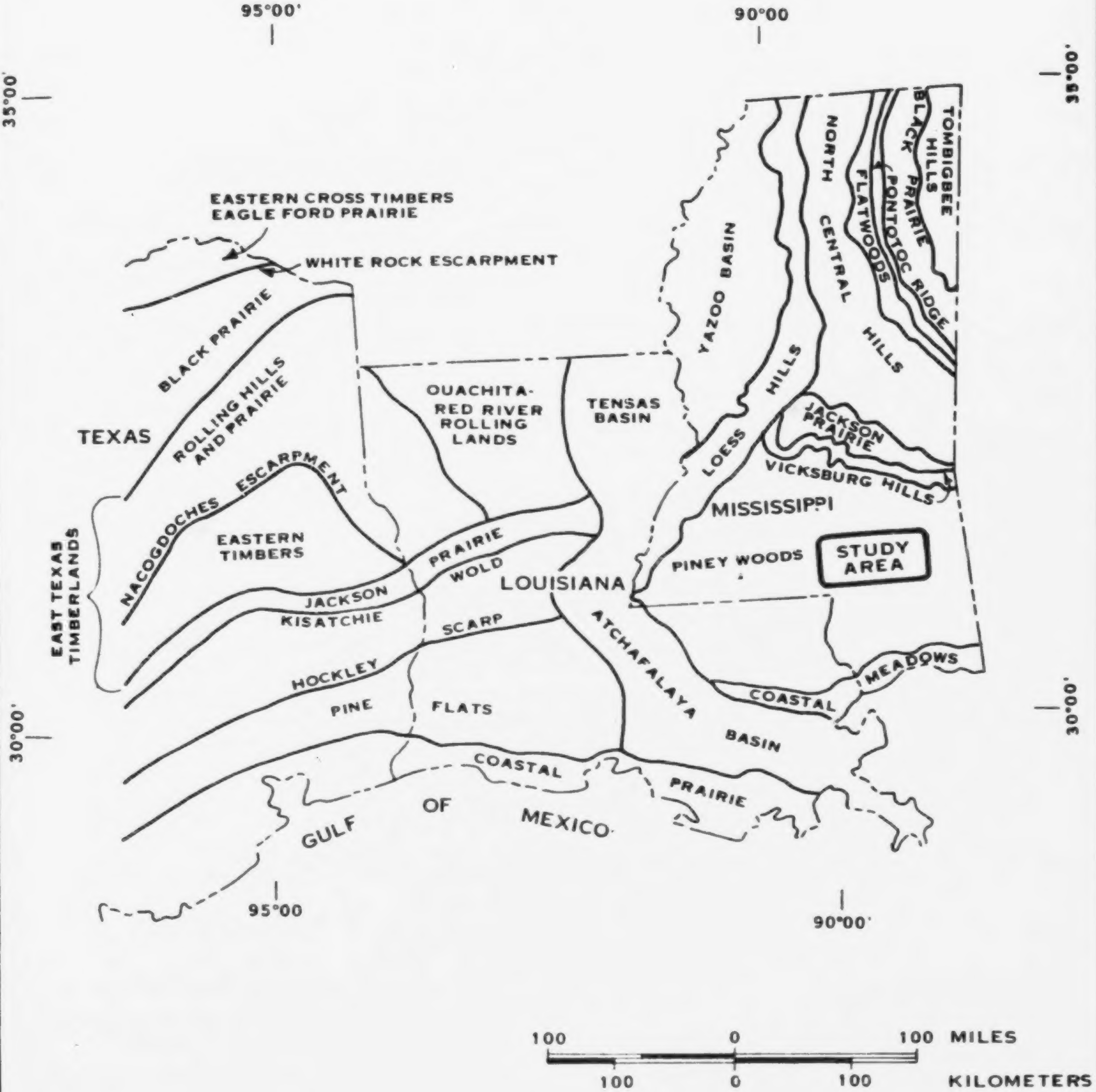
12-4). Progressively older strata are exposed to the northeast. The western margin is marked by Quaternary alluvium and loess deposits of the Mississippi River Valley, and the southern margin is bordered by the Quaternary deposits of the Coastal Meadows.

The areal extent of the Piney Woods Subprovince in Mississippi corresponds to the outcrop of the Pascagoula-Hattiesburg and Catahoula Formations, which are late Tertiary in age, and consist of shallow marine and fluviatile deposits (May, 1974). Overlying these units are the Citronelle Formation and various terrace and alluvial deposits, all late Pliocene or Quaternary in age, and all indicative of a fluviatile depositional environment (Williams, 1967). All contacts between these outcropping formations are unconformable (Williams, 1967; May, 1974).

The study area is situated within the southeastern portion of the Mississippi Salt Basin (Figure 12-5), a deep asymmetric depression, elongated northwest-southeast, which extends from northeastern Louisiana to southwestern Alabama. Structural expression of the salt basin is masked by the relatively undeformed sediments of Tertiary and younger age, as are the deep-seated structures within the study area. Known faults are not obviously reflected in the surface, nor do they generally coincide with lineaments in the study area. Topographic expression of the three candidate piercement salt domes is discussed in the respective Surface Features sections of Chapter 13.

Topography in the study area is generally gently rolling (Figure 12-2) but hilly and rugged in areas where local induration of the Pascagoula-Hattiesburg Formation has occurred.

AF 12338A


95°00'
90°00
35°00'
35°00'
EASTERN CROSS TIMBERS
EAGLE FORD PRAIRIE
WHITE ROCK ESCARPMENT
BLACK PRAIRIE
ROLLING HILLS AND PRAIRIE
TEXAS
NACOGDOCHES ESCARPMENT
EASTERN TIMBERS
EAST TEXAS TIMBERLANDS
OUACHITA-RED RIVER ROLLING LANDS
TENSAS BASIN
YAZOO BASIN
NORTH CENTRAL HILLS
FLATWOODS
PONTOTOC RIDGE
BLACK PRAIRIE
TOMBIGBEE HILLS
LOESS HILLS
JACKSON PRAIRIE
VICKSBURG HILLS
MISSISSIPPI
PINEY WOODS
STUDY AREA
JACKSON PRAIRIE
WOLD
LOUISIANA
KISATCHIE
SCARP
HOCKLEY
PINE
FLATS
ATCHAFALAYA BASIN
COASTAL MEADOWS
COASTAL
PRAIRIE
GULF OF MEXICO
30°00'
30°00'
95°00
90°00'
100
0
100 MILES
100
0
100
KILOMETERS

MODIFIED FROM FISK (1944), FENNEMAN(1938), PRIDDY (1960)

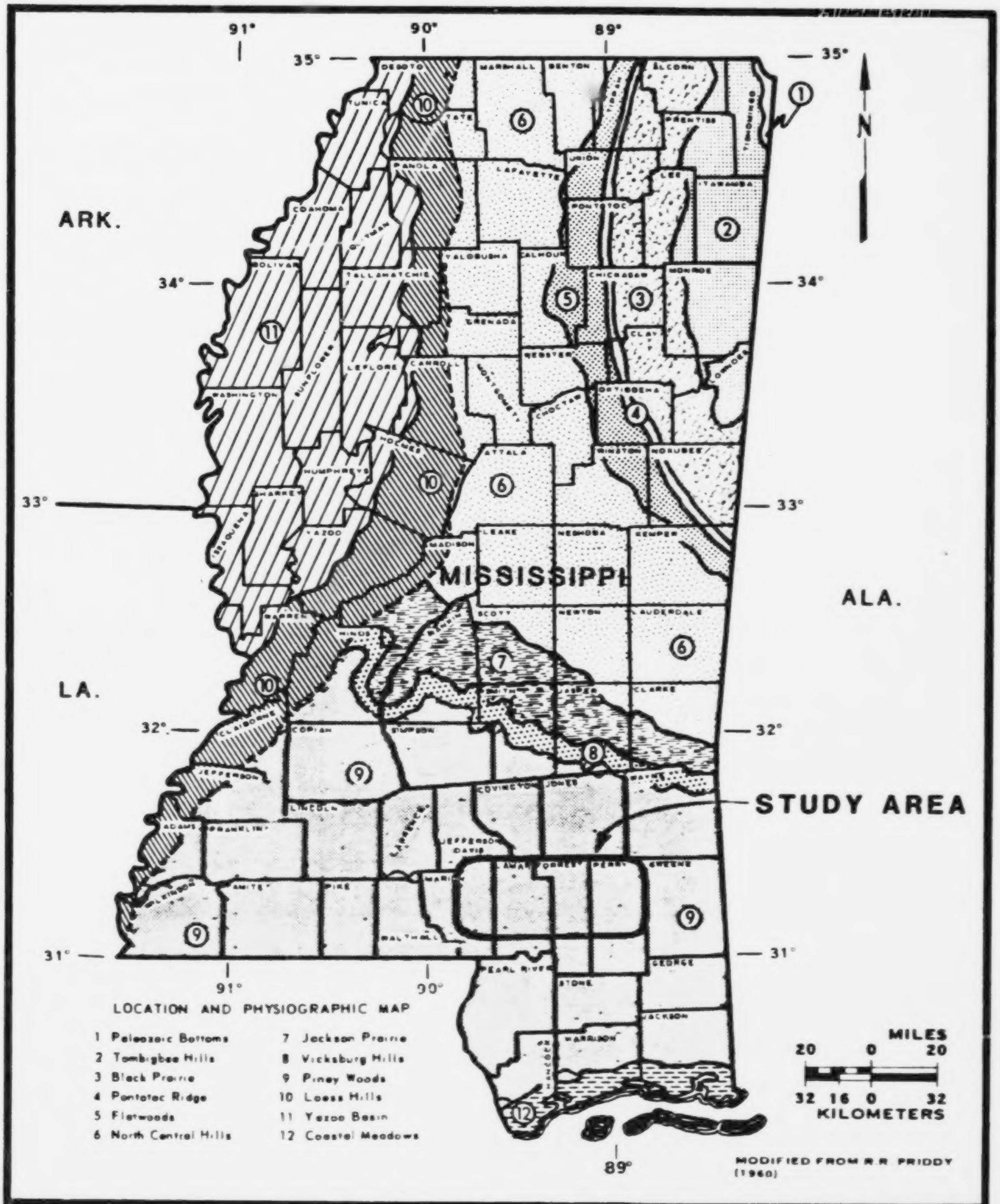
PREPARED DATE
REVISED DATE
REVISED DATE
APPROVED DATE
T-1470-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
REGIONAL PHYSIOGRAPHIC FEATURES

JOB NO. MV9600 FIGURE 12-3

7 BEST DOCUMENT AVAILABLE


91°
90°
89°
35°
34°
33°
32°
31°
N
ARK.
LA.
ALA.
MISSISSIPPI
STUDY AREA
DESOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TISHOMINGO
PRENTISS
TUNICA
TATE
UNION
PANOLA
LAFAYETTE
LEE
ITAWAMBA
PONTOTOC
COAHOMA
QUITMAN
YALOBUSHA
CALHOUN
CHICKASAW
MONROE
BOLIVAR
TALLAHATCHIE
GRENADA
CLAY
SUNFLOWER
LEFLORE
CARROLL
WEBSTER
MONTGOMERY
LOWNDES
WASHINGTON
CHOCTAW
OKTIBBEHA
HOLMES
ATTALA
WINSTON
NOXUBEE
HUMPHREYS
SHARKEY
ISSAQUENA
YAZOO
MADISON
LEAKE
NESHOBA
KEMPER
WARREN
HINDS
RANKIN
SCOTT
NEWTON
LAUDERDALE
SMITH
JASPER
CLARKE
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
WAYNE
COVINGTON
JONES
LINCOLN
ADAMS
FRANKLIN
LAWRENCE
JEFFERSON DAVIS
LAMAR
FORREST
PERRY
GREENE
WILKINSON
AMITE
PIKE
MARION
WALTHALL
PEARL RIVER
STONE
GEORGE
HARRISON
JACKSON
HANCOCK
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
MILES
20 0 20
32 16 0 32
KILOMETERS
LOCATION AND PHYSIOGRAPHIC MAP
1 Paleozoic Bottoms
2 Tombigbee Hills
3 Black Prairie
4 Pontotoc Ridge
5 Flatwoods
6 North Central Hills
7 Jackson Prairie
8 Vicksburg Hills
9 Piney Woods
10 Loess Hills
11 Yazoo Basin
12 Coastal Meadows
MODIFIED FROM R.R. PRIDDY (1960)

PREPARED	[illegible]	DATE	[illegible]
REVISED	[illegible]	DATE	[illegible]
REVISED		DATE	
APPROVED	[illegible]	DATE	[illegible]

T-1466-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM

GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

PHYSIOGRAPHIC MAP

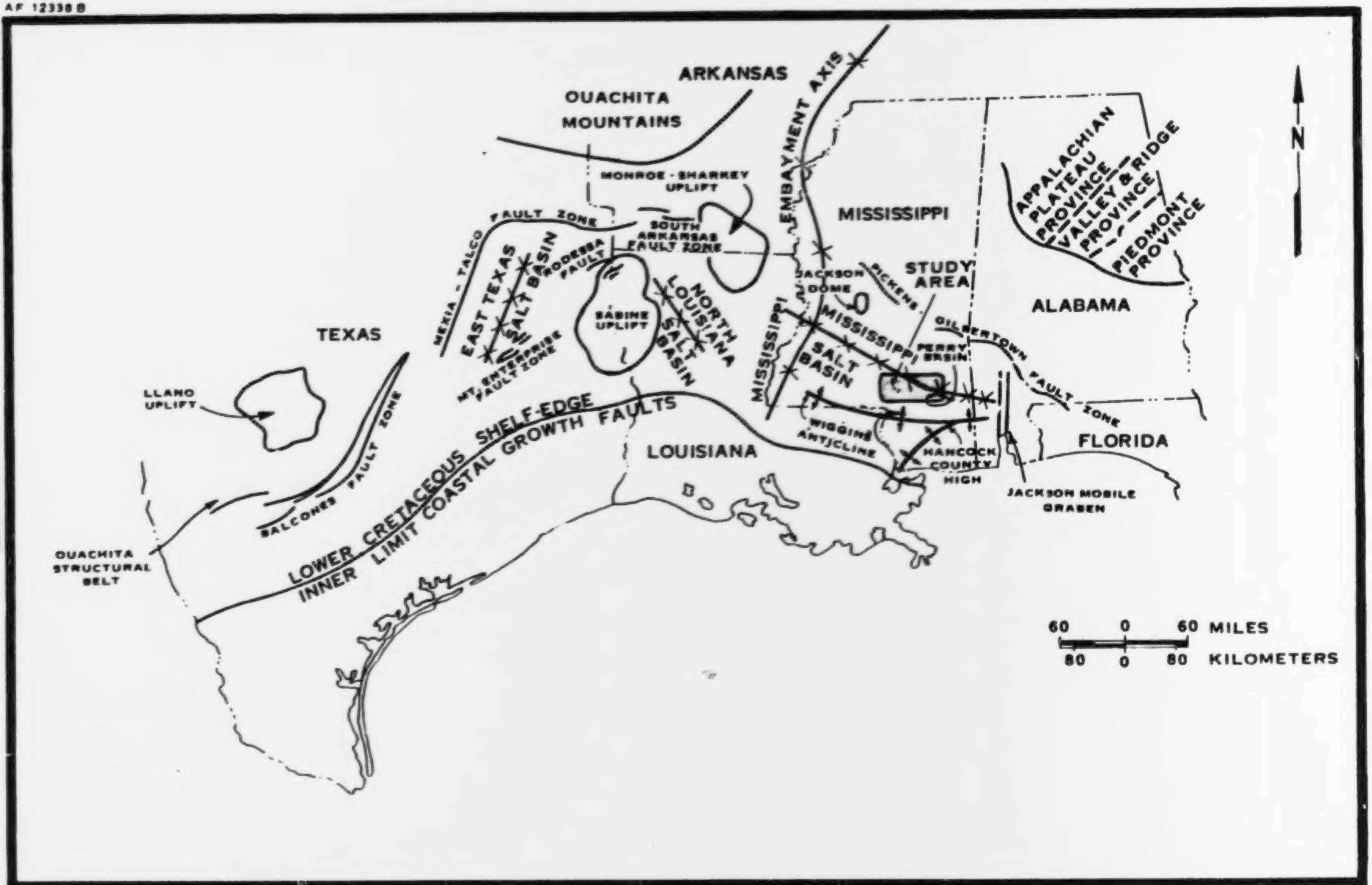
JOB NO. MV9600

FIGURE 12-4

BEST DOCUMENT AVAILABLE

8 [redacted]

AF 12338 B


ARKANSAS
OUACHITA MOUNTAINS
EMBAYMENT AXIS
MONROE - SHARKEY UPLIFT
SOUTH ARKANSAS FAULT ZONE
MEXIA - TALCO FAULT ZONE
EAST TEXAS SALT BASIN
RODESSA FAULT
SABINE UPLIFT
NORTH LOUISIANA SALT BASIN
MT. ENTERPRISE FAULT ZONE
MISSISSIPPI
JACKSON DOME
PICKENS
STUDY AREA
MISSISSIPPI SALT BASIN
MISSISSIPPI
PERRY BASIN
GILBERTOWN FAULT ZONE
WIGGINS ANTICLINE
HANCOCK COUNTY HIGH
JACKSON MOBILE GRABEN
APPALACHIAN PLATEAU PROVINCE
VALLEY & RIDGE PROVINCE
PIEDMONT PROVINCE
ALABAMA
FLORIDA
N
TEXAS
LLANO UPLIFT
BALCONES FAULT ZONE
OUACHITA STRUCTURAL BELT
LOWER CRETACEOUS SHELF-EDGE
INNER LIMIT COASTAL GROWTH FAULTS
LOUISIANA
60 0 60 MILES
80 0 80 KILOMETERS

PREPARED J. Duke DATE 8-15-80
REVISED D.F. DATE 10/9/81
REVISED DATE
APPROVED DATE

T-1465-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
GULF COAST REGIONAL
STRUCTURAL FEATURES

JOB NO. MV9600 FIGURE 12-5

FIGURE 12-5

BEST DOCUMENT AVAILABLE

9

Elevations range from about 122 meters (400 ft) above sea level in the northern portion to about 30 meters (100 ft) above sea level in the south. The area has been maturely dissected by tributaries of the Pascagoula and Pearl Rivers, which trend headward in northerly and northwesterly directions in wide, flat-bottomed, steep-sided valleys, 30 to 91 meters (100 to 300 ft) deep (Fenneman, 1938). The valleys are terraced and are often separated by asymmetric divides, termed cuestas, with gentle southwesterly slopes corresponding to the regional dip of the beds (Foster and McCutcheon, 1941).

Topographic elements in the study area have little preferred orientation, although the surface is dominated by the extensive dendritic fluvial dissection typically imposed upon gently dipping strata in humid regions. Erosional processes are controlled by three factors: regional and local structure, lithology of the outcropping strata, and base-level change.

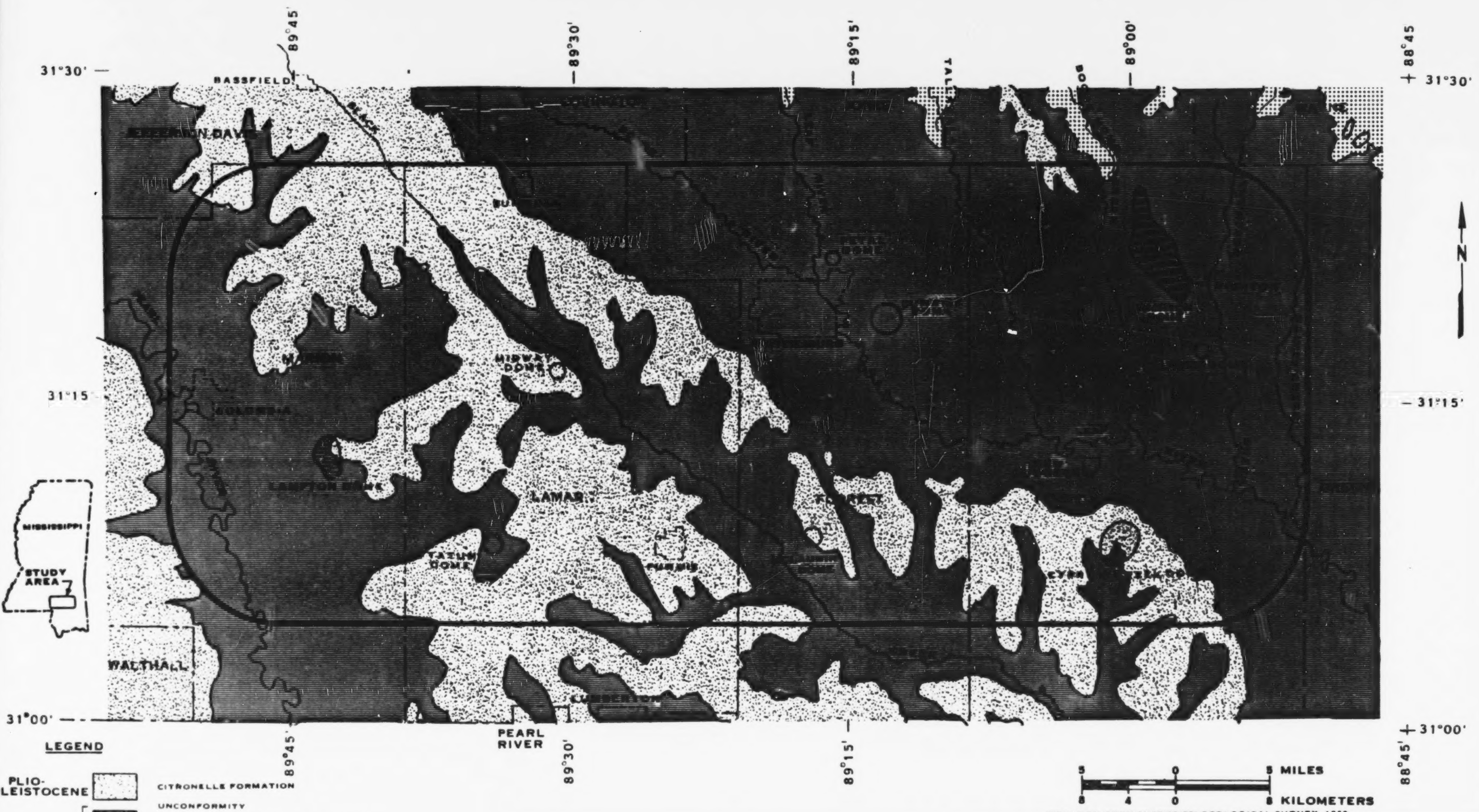
Regional structure is reflected in the development of large-scale cuestas (Foster and McCutcheon, 1941) or asymmetric divides, a good example of which occurs between the Leaf River and Black Creek (Figure 12-2). Longer streams and gently rolling topography are characteristic of the gentler slope, which generally slopes to the southwest. The northward facing slopes, while relatively rugged and steep, are modified by valley terraces (Foster and McCutcheon, 1941).

Lithologic control of topography within the study area is confined to the outcrop of the Pascagoula-Hattiesburg and Citronelle Formations and, to a lesser extent, the younger terrace deposits. The sands, sandstones, and clays of the Catahoula Formation are only exposed in northern Perry County, within the valley of Bogue Homo Creek (Figure 12-6). The Pascagoula-Hattiesburg unit consists of silts, clays, sands, and some lignitic or carbonaceous material. Some of these sands are locally indurated sandstones (Williams, 1967). Field mapping during the Area Characterization study in Perry County showed that the Pascagoula-Hattiesburg unit is sometimes resistant to erosion and is sometimes exposed at the higher elevations. The Citronelle Formation, which overlies the Pascagoula-Hattiesburg unit, consists of silty, clayey sands, gravelly sands, and discontinuous clay beds. Erosionally resistant sediments of the Citronelle Formation commonly cap the hills and form most of the topographic highs in the study area.

The Citronelle Formation was initially laid down as a widespread deposit, extending from East Texas to Alabama, formed by coalescing flood plains of gulfward flowing streams merging to form coastwise terraces near the Gulf. This alluvial blanket was subsequently eroded and dissected by stream action in response to successive lowerings of the regional base level caused by changes in sea level. This resulted in the development of younger terraces at progressively lower topographic levels, forming steps down to the present drainage courses in the stream valleys (May, 1974). Thus, the Citronelle is the oldest and topographically the highest coastwise terrace (May, 1974). Recent alluvium, where terraced, composes the lowest, youngest terrace.

The terraces are thought to be of depositional origin, but Williams (1967) discussed the possibility that they were "cut" terraces caused by planation when the sea level was much higher than at present. Fluctuations in base level caused changes from aggradation to renewed incision, developing terraces from the combined processes of planation, aggradation, and subsequent dissection of fluvial material. Thus, the reworking and redeposition of materials derived from the Citronelle Formation into a series of depositional terraces in the study area record a series of base-level changes following deposition of the Citronelle Formation.

The study area is drained by two major river systems, the Pearl and Pascagoula, with the drainage divide occurring in western Lamar County (Figures 12-7 and 14-1). The Pearl River flows southeasterly across the southwestern corner of the study area. No major tributaries exist within the study area, and minor tributaries generally flow southwesterly and southeasterly to join the major stream. The Pascagoula River is formed by the confluence of the Leaf and Chickasawhay Rivers southeast of the study area in northern George County (Figure 14-2). Within the study area, the major tributaries include Black Creek and the Bowie and Leaf Rivers, which flow in a southeasterly direction, and the generally southerly flowing Tallahala, Bogue Homo, Thompson, and Gaines Creeks. A striking parallelism is displayed by the larger streams in the study area, which flow in southerly and southeasterly directions.



31°30'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
MARION
COLUMBIA
LAMPTON DOME
TATUM DOME
MIDWAY DOME
LAMAR
PURVIS
FORREST
CYPR
WALTHALL
LUMBERTON
PEARL RIVER
MISSISSIPPI
STUDY AREA
N
5 0 5 MILES
8 4 0 8 KILOMETERS

GEOLOGY FROM MISSISSIPPI GEOLOGICAL SURVEY, 1969

LEGEND

PLIO-PLEISTOCENE	░	CITRONELLE FORMATION
		UNCONFORMITY
MIOCENE	▓	PASCAGOULA HATTIESBURG FORMATION
	▒	CATAHOULA FORMATION

- — — COUNTY LINE
- ⬭ CANDIDATE SALT DOME -3000 FEET SALT CONTOUR
- ○ NON-CANDIDATE SALT DOME

PREPARED		DATE	
REVISED		DATE	
REVISED		DATE	
APPROVED		DATE	

T-1235-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

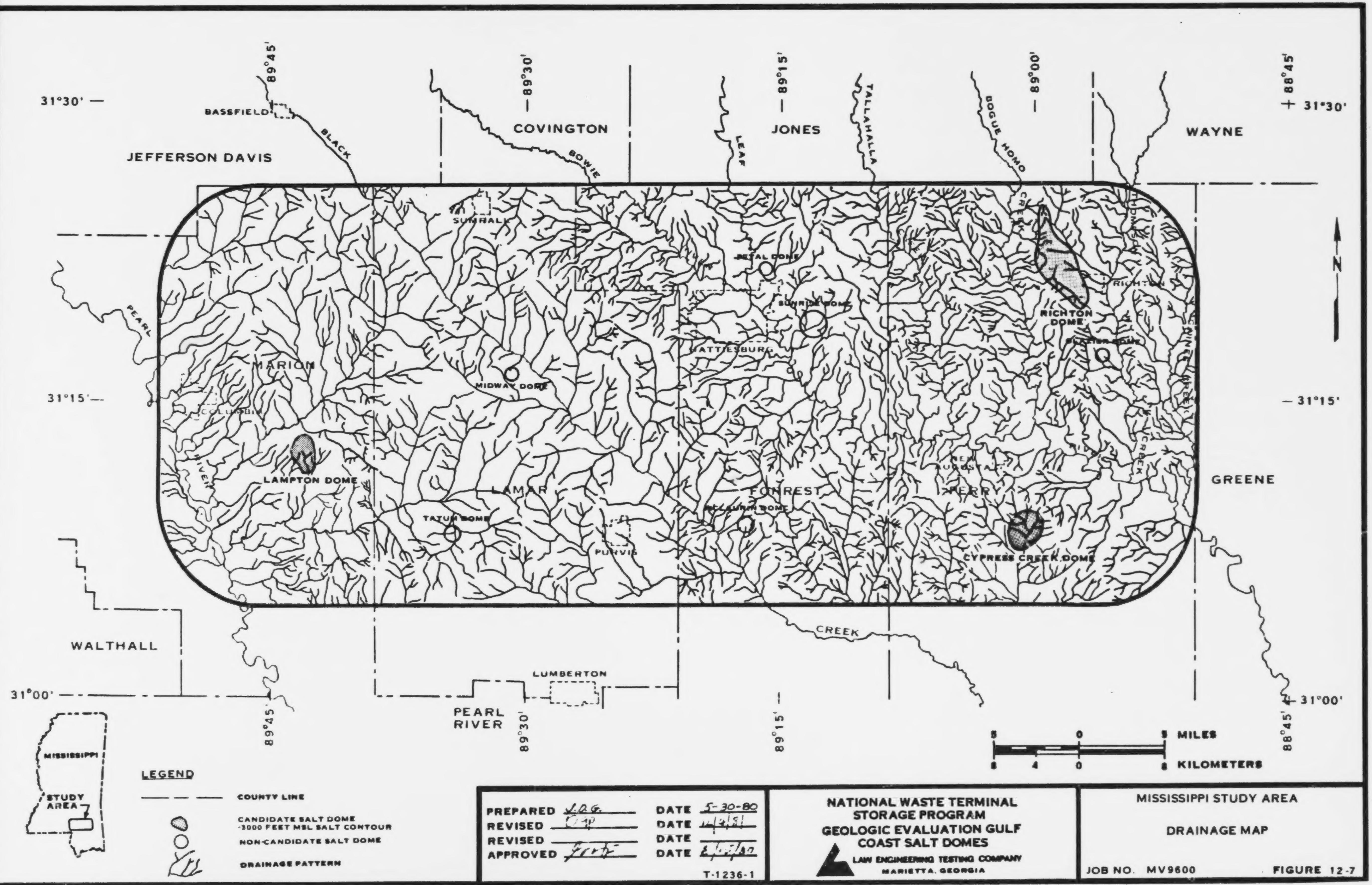
MISSISSIPPI STUDY AREA

GEOLOGIC MAP

JOB NO. MV9600

FIGURE 12-6

BEST DOCUMENT AVAILABLE


89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
31°15'
31°00'
BASSFIELD
BLACK
BOWIE
LEAF
TALLAHALLA
BOGUE HOMO
CREEK
THOMPSON
COVINGTON
JONES
WAYNE
JEFFERSON DAVIS
SUMRALL
PETAL DOME
SUNRISE DOME
HATTIESBURG
RICHTON
RICHTON DOME
RIVERTON DOME
PEARL
MARION
COLUMBIA
MIDWAY DOME
RIVER
LAMPTON DOME
LAMAR
FORREST
PERRY
NEW AUGUSTA
GREENE
TATUM DOME
McLAURIN DOME
PURVIS
CYPRESS CREEK DOME
CREEK
WALTHALL
LUMBERTON
PEARL RIVER
N
5 0 5 MILES
8 4 0 8 KILOMETERS
MISSISSIPPI
STUDY AREA
LEGEND
COUNTY LINE
CANDIDATE SALT DOME -3000 FEET MSL SALT CONTOUR
NON-CANDIDATE SALT DOME
DRAINAGE PATTERN

PREPARED J.R.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1236-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

DRAINAGE MAP

JOB NO. MV9600

FIGURE 12-7

BEST DOCUMENT AVAILABLE

Drainage density is greater in the eastern portion of the study area (Figure 12-7), corresponding to the Pascagoula River drainage basin, than in the Pearl River Basin to the west. This lower drainage density is attributable to the pervious Citronelle sediments exposed over a larger portion of the Pearl River Basin, thus allowing increased infiltration of surface-water runoff. Drainage principally follows a dendritic pattern, with some areas near the major drainage courses tending toward a subdendritic pattern. Visual assessment of the study area drainage reveals no local anomalies.

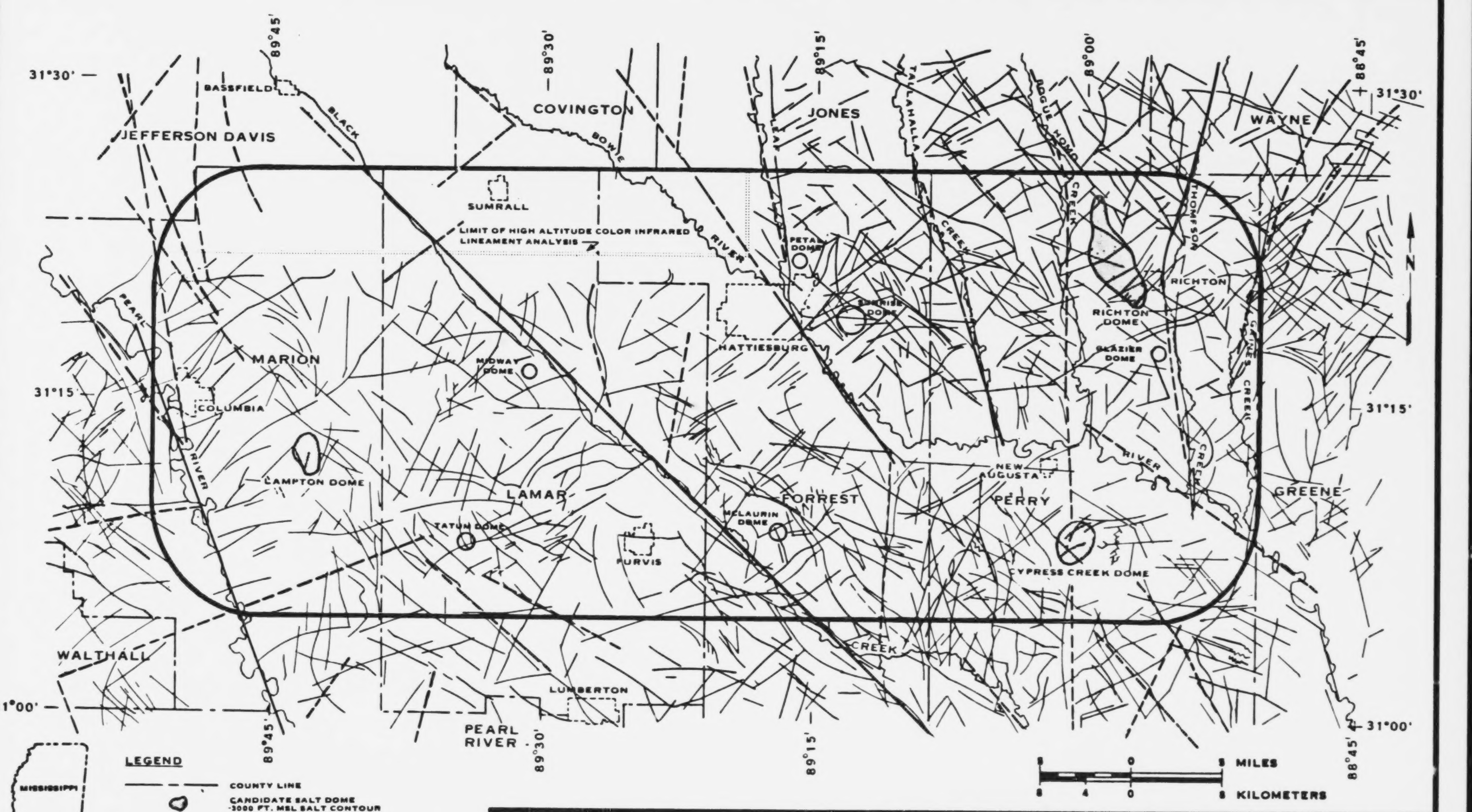
Lineaments identified on Landsat imagery, principally based on long, straight drainage courses, exhibit a strong northwest-southeast orientation throughout the study area, and weaker north-south and northeast-southwest modes in its eastern half (Figure 12-8). No other definite lineament orientation sets were observed.

Most long (greater than 40 km (25 mi)) lineaments in the study area correspond to major trunk channels in the drainage system, which display a northwesterly trend. No obvious relationships could be established between either the locations of individual salt domes, or known subsurface salt ridges, and the regional distribution of lineaments identified on the Landsat imagery.

Lineaments identified from color infrared aerial photographs show a strong bimodal orientation, with sets trending roughly northwest-southeast and northeast-southwest at an angle of about 80 degrees to one another. Less prominent lineament sets trending northerly and westerly are also present. Lineaments of greater-than-average length predominantly belong to the northwest-southeast set, which is consistent with the lineament distribution observed on the Landsat imagery. The distinct bimodal orientation of short and intermediate-length lineaments is not recognized in the orientation of the longer lineaments noted on the Landsat images.

Large variations in density of the lineaments identified on the color infrared photographs are observed throughout the study area, but they show no recognizable relationship to the locations of salt domes in the study area. Long (64-km (40-mi)) linear belts of low lineament density occur at several places in the study area. These belts correspond to the major drainage courses and are caused by masking of lineaments by thick alluvial deposits.

12.2.2 STRATIGRAPHY: The stratigraphic section of the Mississippi Study Area, which is situated within the southeastern portion of the Mississippi Salt Basin, consists of Mesozoic and Cenozoic age sedimentary sequences. The formations recognized and their stratigraphic relationships are shown in the study area Stratigraphic Chart (Table 12-1). These sequences represent a repetitious, cyclic history of marine transgressions and regressions over the Louann Salt, which is at the base of the sedimentary sequence. In northern Mississippi, the sedimentary section unconformably overlaps units ranging from Pennsylvanian to Lower Ordovician in age. Within the study area and southward


31°30'
89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
BASSFIELD
BLACK
COVINGTON
BOWIE
JONES
TALLAHALLA
BOGUE HOMO
WAYNE
JEFFERSON DAVIS
SUMRALL
LIMIT OF HIGH ALTITUDE COLOR INFRARED LINEAMENT ANALYSIS
RIVER
PETAL DOME
CREEK
CREEK
THOMPSON
N
RICHTON
PEARL
SUNRISE DOME
RICHTON DOME
GLAZIER DOME
HATTIESBURG
MARION
MIDWAY DOME
31°15'
COLUMBIA
31°15'
GAINES CREEK
RIVER
RIVER
NEW AUGUSTA
CREEK
LAMPTON DOME
LAMAR
FORREST
PERRY
GREENE
McLAURIN DOME
TATUM DOME
PURVIS
CYPRESS CREEK DOME
WALTHALL
CREEK
LUMBERTON
31°00'
31°00'
89°45'
PEARL RIVER
89°30'
89°15'
88°45'
5 0 5 MILES
8 4 0 8 KILOMETERS
MISSISSIPPI
STUDY AREA
LEGEND
COUNTY LINE
CANDIDATE SALT DOME -3000 FT. MSL SALT CONTOUR
NON-CANDIDATE SALT DOME
HIGH ALTITUDE COLOR INFRARED LINEAMENT
DEFINITE LANDSAT LINEAMENT
INDEFINITE LANDSAT LINEAMENT

PREPARED J.D.G. DATE 5-30-80
REVISED DEY DATE 11/4/9
REVISED DATE
APPROVED DATE 8/15/80
T-1237-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

LINEAMENT MAP

JOB NO. MV9600

FIGURE 12-8

BEST DOCUMENT AVAILABLE

AE 12238A

[illegible]	[illegible]	SERIES	GROUP OR STAGE	FORMATION	AGE MYBP	[illegible]	LITHOLOGY
CENOZOIC	QUATERNARY	RECENT		ALLUVIUM		0-125	Quartz sands, chert and quartz gravels, and silty clays
		PLEISTOCENE		TERRACE DEPOSITS		0-50	Fine to coarse grained quartz sands with some gravel and clay lenses
		PLIO-PLEISTOCENE		CITRONELLE	1.8	150 ±	Silty, clayey sands grading into basal gravel beds
	TERTIARY	PLIO-MIOCENE		PASCAGOULA HATTIESBURG		350 to 2200	Interbedded gravelly sands, sands, silty clays, and lignites
		MIOCENE		CATAHOULA	22.5	Up to 1,000	Silts, clays, fine to medium grained sands, gravels, lignites and a marker Heterostegina zone (Tatum limestone member)
		OLIGOCENE		PAYNES HAMMOCK		5-23	Glauconitic marls interbedded with sandstones, clays, and silty limestones
				CHICKASAWHAY		30	Argillaceous to sandy limestones interbedded with clays and marls
			VICKSBURG	BUCATUNNA		50-215	Clayey sandstones or sandy marls interbedded with lignitic, calcareous clays
				VICKSBURG LIMESTONES UNDIFF			Limestones with associated bentonites, clay shales, and clays
				FOREST HILL RED BLUFF UNDIFF	36	55-150	Sandy to silty carbonaceous clays and partially indurated fossiliferous marls
		EOCENE	JACKSON	YAZOO		Up to 500	Variably limy, glauconitic sandy and silty clays with basal chalky limestones (Ocala facies)
				MOODYS BRANCH	42	Up to 45	Glauconitic, partially indurated and sometimes sandy marls
			CLAIBORNE	COCKFIELD		25-215	Limestones, sand streaked, lignite bearing clays and silts
				COOK MOUNTAIN	44.5	115-235	Loosely cemented, porous carbonate sands, glauconitic clay shales, and calcarenitic limestones
				KOSCIUSKO (SPARTA)	46	90-625	Slightly porous, chalky limestones, well cemented calcarenitic limestones interbedded with glauconitic clay shales, locally sandy
				ZILPHA			Interbedded glauconitic clay shales, chalks, and chalky limestones
				WINONA		90-200	Clay shales containing chalk or marl lentils in the lower half
				TALLAHATTA			Glauconitic and limy siltstones and claystones interbedded with clay shales
				MERIDIAN	50	49-90	Crossbedded sands containing sandy shales and lignitic clays
		?	WILCOX	UNDIFF	53.5	2,250-3,200	Silty, lignitic shales interbedded with silts, sands, lignitic siltstones, and fine to medium grained sandstones
		PALEOCENE	MIDWAY	PORTERS CREEK		550-1,050	Shales interbedded with thin lignite beds, silts, siltstones, and very fine to fine grained argillaceous sandstones
				CLAYTON	65	10-25	Sandy, glauconitic marls, marly chalks, or calcareous clays
MESOZOIC	CRETACEOUS	GULFIAN	SELMA	UNDIFF		925-1,500	Sandy to very argillaceous to pure chalks containing bentonite traces and fissile shales
			EUTAW	UNDIFF	92		Fissile, slightly sandy or calcareous, lignitic shales, very fine to fine grained sandstones, and calcareous siltstones
			TUSCALOOSA	UPPER TUSCALOOSA		300-900	Fissile shales, mudstones, and fine to medium grained, glauconitic, porous sandstones
				MIDDLE TUSCALOOSA		620-1,160	Interbedded carbonaceous shales, mudstones, siltstones, and thin, fine grained sandstones with a basal chalk or chalky limestone unit
				LOWER TUSCALOOSA	100		Fissile shales, calcareous and glauconitic sandstones and siltstones with a basal massive, fine to coarse grained conglomeratic sandstone unit
		COMANCHEAN	WASHITA	DANTZLER		570-1,150	Micaceous shales alternating with mudstones, nodular limestones, fine to medium grained, lignitic, calcareous or silty sandstones
			FREDERICKSBURG	WASHITA-FREDERICKSBURG UNDIFF	104	1,000-1,880	Shales, silty mudstones, fine to medium grained, silty, carbonaceous sandstones, and pseudo-oolitic, sometimes sandy limestones
			TRINITY	PALUXY		1,000-1,450	Fissile shales, lignitic mudstones, and fine to coarse grained, argillaceous, carbonaceous, gravel bearing sandstones
				MOORINGSPORT		200-1,000	Limy shales alternating with mudstones, silty, fine grained sandstones, and pseudo-oolitic anhydrite bearing limestones
				FERRY LAKE		160-240	Shales alternating with oolitic limestones and white anhydrite
				RODESSA PINE ISLAND UNDIFF	113	750 ±	Thin anhydrite stringer bearing shales, very fine to fine grained, calcareous sandstones and siltstones, and pseudo-oolitic limestones
		COAHUILAN	NUEVO LEON	SLIGO		300	Splintery shales interbedded with fine to medium grained, argillaceous sandstones, and occasionally nodular limestones
				HOSSTON	135	1,800-2,650 ±	Very fine to coarse grained, calcareous sandstones, sandy carbonaceous shales, and sandy, lignitic mudstones
	JURASSIC	UPPER	COTTON VALLEY	UNDIFF	143	[illegible]-2,400 ±	Fine to medium grained, silty and calcareous sandstones alternating with mudstones and shales
			LOUARK	HAYNESVILLE BUCKNER		1,500-3,450 ±	Dense, lithographic limestones, dolomitic carbonates, and anhydrite
				SMACKOVER			Dense, oolitic limestones, finely crystalline limestones, dolomitic limestones, and dolomites
				NORPHLET			Sandy shales and poorly sorted, shaley sandstones
		LOWER	LOUANN	LOUANN SALT		[illegible]-5,000 ±	Coarsely crystalline, white halite containing anhydrite inclusions

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

STRATIGRAPHIC CHART

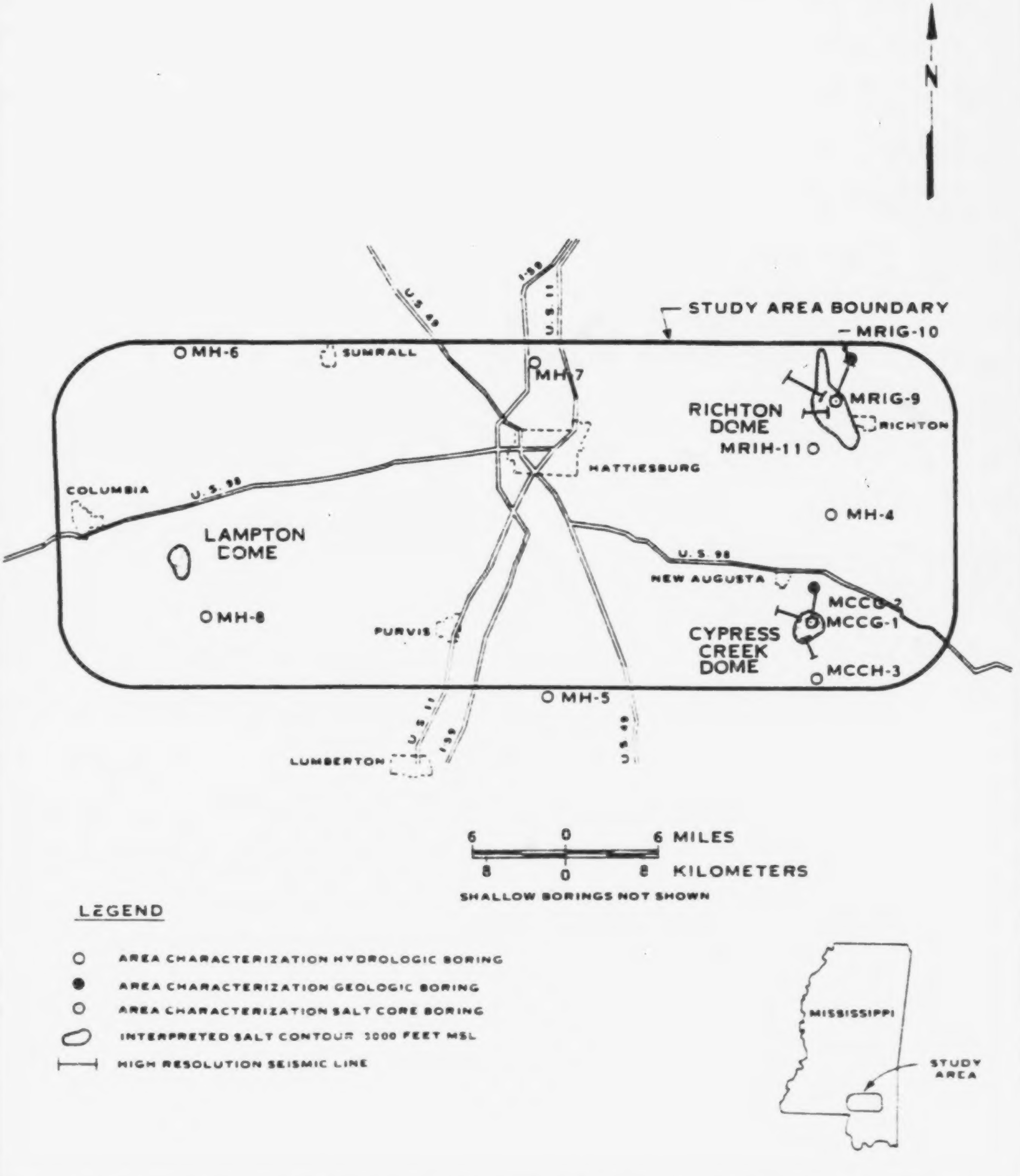
JOB NO. MV9600 TABLE 12-1

18 BEST DOCUMENT AVAILABLE

(downdip), the sequence is too thick and extends too deep to permit complete investigation of the sub-salt basement rock. No deep wells have been drilled and seismic records are indecipherable at these depths. Regionally, the section ranges in thickness from a feather edge in northern Mississippi, where most of the section is missing, to approximately 8,230 meters (27,000 ft) in the southeastern portion of the study area, the result of massive sediment accumulations in the Mississippi Salt Basin largely during Jurassic and Cretaceous times (Mellen, 1958).

Sources of sediment for the various units within the study area ranged from reworked sediments of nearby older depositional sequences (Mellen, 1958) to sediments brought in by major river systems from distant, uplifted regions to the north (Rainwater, 1964).

This section of the report briefly describes the general stratigraphy in the study area, including the Late Triassic-Early Jurassic Louann Salt to Recent alluvial deposits. The study area Geologic Map (Figure 12-6) discussed previously depicts only those formations which are exposed at the surface in the study area. Typical regional thicknesses for all stratigraphic units in southeastern Mississippi, which are indicated in the text and on the Stratigraphic Chart (Table 12-1), are taken from Eargle (1964) unless specified otherwise. Thicknesses for the Paleocene, Clayton through Miocene, Hattiesburg Formations were obtained from analyses of the deep geologic and hydrologic well data (Figure 12-9) developed for Area Characterization, including cutting samples, sidewall cores and geophysical logs, and were


N
STUDY AREA BOUNDARY
MRIG-10
MH-6
SUMRALL
MH-7
U.S. 49
I-59
U.S. 11
RICHTON DOME
MRIG-9
RICHTON
MRIH-11
HATTIESBURG
COLUMBIA
U.S. 98
LAMPTON DOME
MH-4
U.S. 98
NEW AUGUSTA
MCCG-2
MCCG-1
CYPRESS CREEK DOME
MH-8
PURVIS
MCCH-3
MH-5
U.S. 11
I-59
U.S. 49
LUMBERTON
6 0 6 MILES
8 0 8 KILOMETERS
SHALLOW BORINGS NOT SHOWN
LEGEND
AREA CHARACTERIZATION HYDROLOGIC BORING
AREA CHARACTERIZATION GEOLOGIC BORING
AREA CHARACTERIZATION SALT CORE BORING
INTERPRETED SALT CONTOUR 3000 FEET MSL
HIGH RESOLUTION SEISMIC LINE
MISSISSIPPI
STUDY AREA

PREPARED [illegible] DATE [illegible]
REVISED [illegible] DATE [illegible]
REVISED ______ DATE ____
APPROVED [illegible] DATE [illegible]
T-1175-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
FIELD INVESTIGATION PLAN

JOB NO. MV9600 FIGURE 12-9

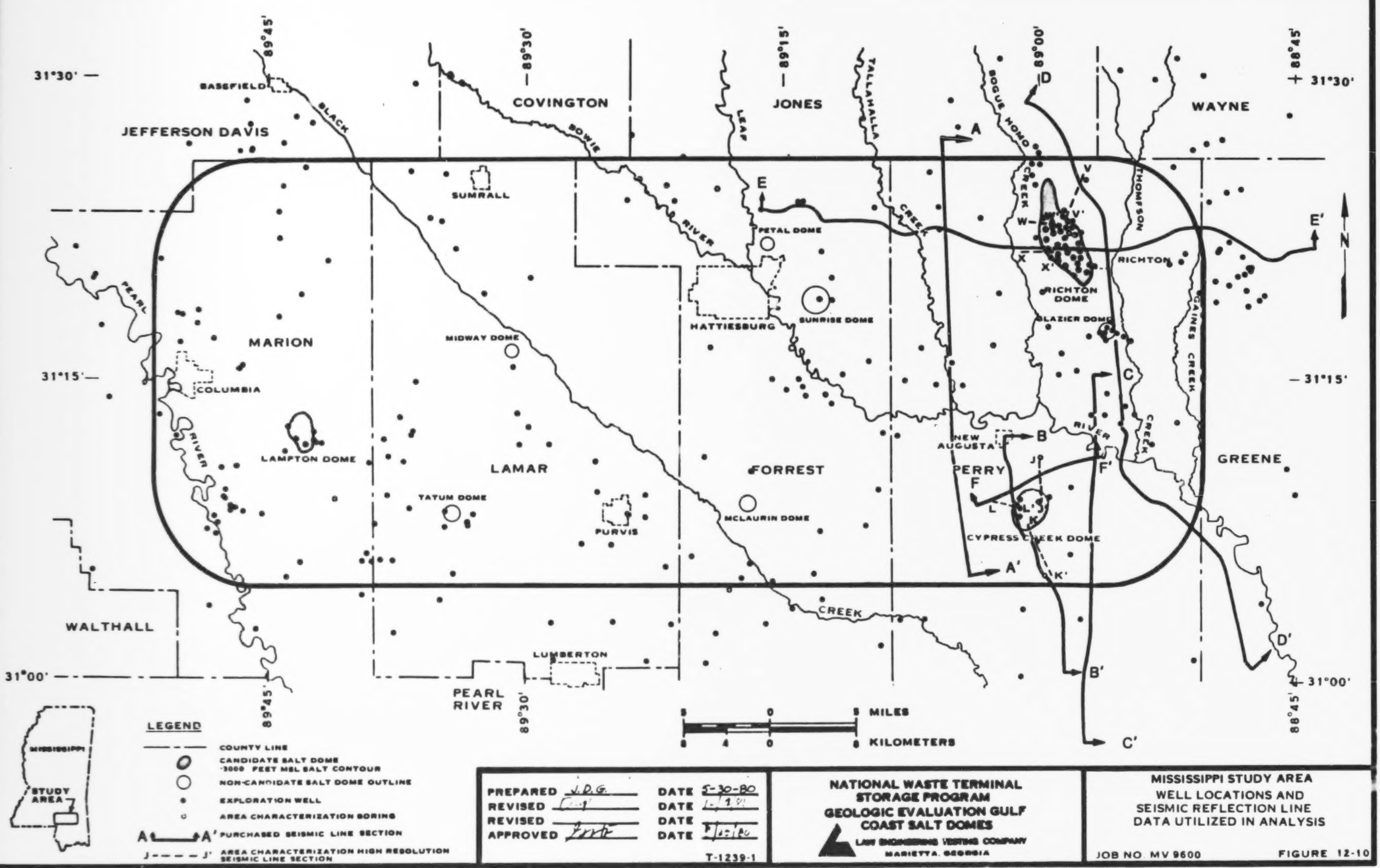
20 BEST DOCUMENT AVAILABLE

supplemented with geophysical logs from existing petroleum exploration wells (Figure 12-10 and Table 12-2). The type geophysical log, shown in Figure 12-11, illustrates typical geophysical log signatures used for the identification and correlation of units across the study area. Stratigraphic correlations were then applied to the definition of structural elements in the study area (Figure 12-12) discussed in Section 12.2.3.

12.2.2.1 Jurassic System: The Jurassic System includes the Lower and Upper Jurassic Series.

12.2.2.1.1 Lower Jurassic Series - The only beds recognized to be in the Lower Jurassic Series are those of the Louann Group.

12.2.2.1.1.1 Louann Group: The Louann Group here involves only the Louann Salt Formation, which was deposited in a restricted marine environment on top of Triassic or older clastic rocks (Rainwater, 1963). There have been many attempts to determine the age of the Louann Formation. Jux (1961) studied previous articles on the subject and then, through palynologic research, concluded that the Louann Salt was probably deposited during the time interval from the Late Triassic to Early Jurassic. Most stratigraphers generally concurred with this determination. The massively bedded Louann Salt consists of an estimated 1,524 meters (5,000 ft) of halite with anhydrite inclusions. The Louann Salt is regarded as the mother salt or source bed for the


31°30'
89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
BLACK
BOWIE
LEAF
TALLAHALLA
BOGUE HOMO
CREEK
THOMPSON
SUMRALL
PETAL DOME
SUNRISE DOME
HATTIESBURG
RICHTON
RICHTON DOME
GLAZIER DOME
GAINES CREEK
A
D
E
E'
V
V'
W
X
X'
N
PEARL
MARION
MIDWAY DOME
31°15'
31°15'
COLUMBIA
RIVER
LAMPTON DOME
LAMAR
TATUM DOME
PURVIS
FORREST
MCLAURIN DOME
NEW AUGUSTA
PERRY
B
C
F
F'
J
J'
L
L'
K
K'
CYPRESS CREEK DOME
A'
GREENE
WALTHALL
CREEK
LUMBERTON
31°00'
31°00'
B'
D'
C'
PEARL RIVER
5 0 5 MILES
8 4 0 8 KILOMETERS
MISSISSIPPI
STUDY AREA
LEGEND
COUNTY LINE
CANDIDATE SALT DOME -3000 FEET MSL SALT CONTOUR
NON-CANDIDATE SALT DOME OUTLINE
EXPLORATION WELL
AREA CHARACTERIZATION BORING
A ⟶ A' PURCHASED SEISMIC LINE SECTION
J - - - - J' AREA CHARACTERIZATION HIGH RESOLUTION SEISMIC LINE SECTION

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE 1-1-81
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1239-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
WELL LOCATIONS AND SEISMIC REFLECTION LINE DATA UTILIZED IN ANALYSIS

JOB NO. MV 9600

FIGURE 12-10

BEST DOCUMENT AVAILABLE

TABLE 12-2

(PAGE 1 OF 8)

BOREHOLE DATA SUMMARY
[illegible] DOME

WELL NAME	LEMCO WELL NO.	LOCATION	ELEV. G.L.	TOTAL DEPTH	LOGS RUN	CASING DIA. (O.D.)--DEPTH	CEMENTING	CASING SEAT DEPTH	ABANDONMENT PROCEDURE	CAPROCK TOP/ THICKNESS PENETRATED	SALT TOP/ THICKNESS PENETRATED	REMARKS
Explore Corp Bradshaw #4 (* +)	M-20	1357'N & 60'W of SE Cor. Sect. 17-3N-17W (* +)	308' (*) 316.6' (+)	1012' (+ *)	N.D.	9 5/8"--167' (+)	N.D.	N.D.	N.D.	-1059' MSL (+)	N.A.	Drilled [illegible] Sulphur Test Cavity D/B Stuck, Abandoned
Explore Corp. Hurst #1 (* E +)	M-21	300'N, 100'W of SE Cor., NE, SE Sect. 17-3N-17W (E + *)	300.4' (+)	1497' (+ *)	SP-RES (R)	16"--72' 10"--1372' 9"--1390' (+) (93' Liner)	N.D.	N.D.	N.D.	-1064.6' MSL/ to TD (+)	N.A.	Bottomed in Anhydrite @ 1497' Depth Sulphur Test
Explore Corp. Bradshaw #5 (* E +)	M-22	600'N 1400'W of SE Cor. Sect. 20-3N-17W (* + E)	331' (*) 331.4' (+)	3000' (* +)	SP-RES (R)	9 5/8"--300' (+)	N.D.	N.D.	N.D.	N.A.	N.A.	Bottomed in Shale - No domal material encountered Sulphur Test
Explore Corp Bradshaw #6 (* E +)	M-23	100'S, 100'W of Center Sect. Sect. 20-3N-17W (E * +)	306' (*) 307' (+)	1847' (* +)	SP-RES (R)	9"--100' (+)	N.D.	N.D.	N.D.	-1291' MSL/ 67' (+)	-1360' MSL/ Bottoms in Salt (+)	Bottomed @ 1847' in Salt Top Anhyd. 1610' Depth Sulphur Test
Explore Corp. Bradshaw #1 (+ E *)	M-24	982'S & 3100'W of NE Cor. Sect. 20-3N-17W (+ * E)	330' (*) 332.7' (+)	3000' (+ *)	SP-RES (R)	N.D.	N.D.	N.D.	N.D.	N.A.	N.A.	Bottomed in Shale - No Domal Material Encountered Sulphur Test
Gulf Refining Co. Bradshaw #1 (+ E *)	M-25	660'S & 660'W From NE Cor. NE 1/4 Sec. Sect. 20-3N-17W (+ * E)	332' (E + *)	1627' (* +) / 1570' (+ E) Sidetrack	SP-RES (R)	13"--156' (+)	Cemented	N.D.	N.D.	-1013' MSL/ To Bottom (+)	N.A.	Sulphur Test Top Anhydrite 1625' Depth BTM @ 1627' Depth Anhy. Plugged Back to 975' with 100 sacks cement, then side-tracked & Drilled to 1570-' Anhy. (*)
Explore Corp Bradshaw #8 (+ E *)	M-26	600' N of Common Cor. Sect. 20,21 28, 29 3N-17W (* +)	350' (*) 350.7' (+)	1515' (+ *)	SP-RES (R)	16"--70' (+)	N.D.	N.D.	N.D.	-1122.3' MSL/ To Bottom (+)	N.A.	Top Anhydrite 1416' Depth Sulphur Test
Explore Corp. Bradshaw #3 (* E +)	M-28	600'N, 1400'E of SW Cor. Sect. 21-3N-17W (* + E)	370.5' (+) 370' (*)	1306' (+ *)	SP-RES (R)	9 5/8"--132' (+)	N.D.	N.D.	N.D.	-1014.5/ To Bottom (+)	N.A.	Cavity D/B Stuck, Abandoned @ 1106' Depth Sulphur Test
Explore Corp. Bradshaw #7 (* E +)	M-29	2636'S & 2577'E of NW Cor. Sect. 21-3N-17W (* S +)	320.1' (+) 325 (*)	1649' (+) 1650' (*)	SP-RES (R)	9 5/8"--132' (+)	N.D.	N.D.	N.D.	-1142.9/ (Anhyd) (+)	N.A.	Sulphur Test Bottom 1649' Depth in Anhydrite
Explore Corp. Bradshaw #7 (E * +)	M-34	616'S & 1980'E of NW Cor. Sect. 28-3N-17W (* E +)	324.1' (+) 324 (*)	1545' (* +)	SP-RES (R)	9 5/8"--133' (+)	N.D.	N.D.	N.D.	-1117.6' MSL/ (Anhyd.) (+)	N.A.	Sulphur Test

NOTE:

All dimensions are in feet

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 12-2

(PAGE 3 OF 8)

BOREHOLE DATA SUMMARY
CYPRESS CREEK DOME

WELL NAME	LETCO WELL NO.	LOCATION	ELEV. G. L.	TOTAL DEPTH	LOGS RUN	CASING DIA. (O.D.)--DEPTH	CEMENTING	CASING SEAT DEPTH	ABANDONMENT PROCEDURE	CAPROCK TOP/ THICKNESS PENETRATED	SALT TOP/ THICKNESS PENETRATED	REMARKS
DOE/USA MCCG-1	MCCG-1	2702' FWL 2520' FSL Sect 9-2N-10W	221.0 (KB) 231'	1899'	Caliper Diff. Temp. Acoustilog Comp. Densilog Comp. Neutron Dual Ind - Focused Dual Laterlog Dual Space- Density	20"--0'-59.0' 13 3/4"--0'- 893.65' 8 5/8"--894'- 1195.01'	0'-59.0' 0'-893.65' 890'-1195.01	1195.01'	N.A.	-953' MSL/ 204'	-1155' MSL/ 513'	Pump Test in Caprock 1202' - 1300' Depth Cored 1202' - 1899' Depth
Shell Oil #1 USA D-6 (+ * X)	P-15	1900' FWL 1980' FWL SECT. 8-2N-10W (+ * X)	207.5' (X) (KB) 200'	14,000' (*)	Dual Induction CBL-C-GR CBL - GR LL - GR Prox Log (X) IES, Density (*) GR-Laterlog (Dill-8) GR-CBL Compensated Densilog (+)	(+) 20" - 200' 13 3/8" - 1302' 9 5/8" - 8973' 2 7/8" Tbg-8653' Workover TBG - 7899' Note: (*) Sets TBGR 8100'	Cemented Cemented Cemented (+ *) Note: No Intervals Given	(+) 8973'	Temporarily Abandoned 1/2/73 - 350' Cmt. Plug 13300-13650' 100' Cmt. Plug Abv. & Below Csg. shoe @ 8973'. (+)	-1128 MSL/30 (X)	-1156' MSL/ 2500 Overhang (X)	(+) Converted to Salt H_2O Disposal well - 10/10/73 Retainer set @ 8600' - Perf. @ 8232'-8245', 8156'-8174', 8004'-8017' & 7960'-7970' - 4 jets/foot 1/14/75 Bridge Plug set @7800' Cemented with 10 BBLS, Tested @ 2000 PSI, perf. 5390-5405, 5413-5425, 5432-5450, 4 SPF - 2 7/8" tubing run packer set @ 5300' (X) As of July, 1979: disposal @ 5186' - 5446' in Wilcox Top of Basal Anhydrite -3740 MSL Top of Sediment below overhang -4002 MSL (X)
Shell Oil #1 USA D-11 (+ * X)	P-16	3072' FSL 1409' FWL Sect 8-2N-10W (+ * X)	236.5 (X) (KB) 263' (X)	16,116' (*)	DILL-8 GR-MLL-3 Sonic Density, EMP Dipmeter (+)(+) LL 3 BHC-AL C-GR CDL-C-GR SWN-GR SNC (X)	(*) 20"--150' 13 3/8"--715' 5 1/2"-- 20"--120' 13 3/8" - 685' (+) 9 5/8"--4640' 7"-- 8,669' 5"--13,677'	Cemented " " (*) " Note: No Intervals Given " " " " (+) "	(+) 13,677'	Producing as of 4/30/79 (+)	-1063 MSL/ 94 (X)	-1157' MSL/ 2775' Overhang (X)	Production - April 1979 1203 BBL Oil 636' MCF Gas (+) Top of Basal Anhydrite -3932 MSL Top of Sediment below Overhang -4555 (X)
Shell Oil #1 USA (*)	P-16A	1900' FSL 1400' FWL Sect 8-2N-10W	230 (Est) See Remarks	2262' (*)	N.D.	16"--50' (+)	N.D.	N.D.	N.D.	N.D.	N.D.	Drilled TD 2262' - Hole Cratered Below 16" Casing Hole Abandoned - Redrilled As Shell #1 USA, D-11 Elevation GL, DF Estimated from data for Shell D-11 (*)
Shell Oil #1 USA D-14 (* +) (Directional Hole)	P-17	600' FSL 2100' FWL Sect. 8-2N-10W (* +)	KB(*) 261' GL 236' (Est)	13,900' (*)	Directional GR - DILL GR-FDC-CNL GR-CCL-CBL (+)	(*) 20"--160' (+) 13 3/8"--1298' 9 5/8"--8872' 5 ½" LNR: 8,414'- 13,097 Tubing 2 7/8"--9506'	Cemented (*) " (+) " " No Interval Data	(+) 13,097	Producing As of 4/30/79 (+)	N.D.	-1037/ 7335 Overhang (X)	Production - April, 1979 495 BBL Oil, 20 BBL H_2O, 1465 MCF GAS (+) Top of Basal Anhydrite -8372 MSL Top of Sediment Below overhang -8575 MSL (X)

NOTES:

All dimensions are in feet

TABLE 12-2

(PAGE 3 OF 8)

BOREHOLE DATA SUMMARY
CYPRESS CREEK DOME

WELL NAME	LETCO WELL NO.	LOCATION	ELEV. G.L.	TOTAL DEPTH	LOGS RUN	CASING DIA. (O.D.)--DEPTH	CEMENTING	CASING SEAT DEPTH	ABANDONMENT PROCEDURE	CAPROCK TOP/ THICKNESS PENETRATED	SALT TOP/ THICKNESS PENETRATED	REMARKS
Shell Oil #1 USA 10-5 (+ * X)	P-10	1550' FWL 360' FNL Sect. 10-3N-10W (+ X)	232' (* X) (KB) 261' (X)	16,300' (* X)	DIL PML BHC GR CNL FDC CBL VDL TDT (+)	Miss. O&G Bd Data 20"--110' (+) 13 3/8"--1402' 9 5/8"--4500' 7"--15,604' 5"--14,300' 2 3/8"--14,310 P.I. CARD 20"--110' 13 3/8"--1402' (*) 9 5/8"--4500'	(+) Cemented " " " " (*) Cemented " No Interval Data	16,300' (+ *)	Tubing Pulled Back T.D. 15,443' Lengths Pulled 9 5/8"--1200' 7"--6850' 5"--11,700' 100' Cement Plug 14,210'- 14,310' 100' Cement Plug 13,150'- 13,250' 50' Cement Plug 11,700'-11,750 50' Cement Plug 8860'- 8910' 100' Cement Plug 6200'- 6300' 100' Cement Plug 4900'- 4800' 100' Cement Plug 4550'- 4450' 100' Cement Plug 1430'- 1330' 25' Cement Plug 30'- 5' 13 3/8" Csg Cut 4.5' Below G.L. 1/2" Steel Plate Welded on Csg 10# Mud used to fill hole (+)	-1096 MSL/ 60 (X)	-1165 MSL/ 3036 Overhang (X)	Officially P&A 9/29/76 (+) Top of Basal Anhydrite -3191 MSL Top of Sediment below overhang -3183 MSL (X)
Shell Oil #1 USA 17-6 (+ * X)	P-19	1976' FWL 2125' FNL Sect. 17-3N-10W (+ * X)	336' Est. From Topo Map	16,500' (+ *)	ES DIL FDC MUD BHC Sonic (+)	Miss O.&G.Bd. Data 20"--160' (+) 13 3/8"--1453' 9 5/8"--9150' (liner) 7"--8905'-14,681' (tubing) 2 7/8"--10,450' P.I. Card (*) 20"--105' 13 3/8"--1453' 9 5/8"--9150' 7" Lnr--8900'-14,686'	Cemented " (+) " " P.I. (*) Cemented	14,681' (+)	Producing as of 30 April, 1979 (First Production 4-9-75) (+)	N.D.	-3080/ 7110 Overhang (X)	Production - April 1979 303 BBL Oil 23 BBL H_2O 547 MCF Gas Top of Basal Anhydrite -8700' MSL Top of Sediment below overhang -8376' MSL (X)

NOTES:
All dimensions are in feet

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 12-2

(SHEET 4 OF 9)

BOREHOLE DATA SUMMARY
RICHTON DOME

WELL NAME	LETCO WELL NO.	LOCATION	ELEV. G. L.	TOTAL DEPTH	LOGS RUN	CASING DIA. (O.D.)--DEPTH	CEMENTING	CASING SEAT DEPTH	ABANDONMENT PROCEDURE	CAPROCK TOP/ THICKNESS PENETRATED	SALT TOP/ THICKNESS PENETRATED	REMARKS
Minsearch #2 Blackstrom (* +)	P-94	100'N & 300'E of SW Cor., NW, SW Sect. 26-5N-10W	(* +) 247' DF	(* +) 722'	N.D.	16"--30' 10"--592' (+)	NO 0' - 50' (+)	N.D.	Pulled 16" Csg (+)	-371' MSL (+ *)	N.A.	Gypsum Top 621' Depth (22' Thick) Anhydrite Top 643' Depth Sulphur Test (+)
Minsearch #1 Cantrell (* +)	P-95	245'N & 55'E of SW Cor., NW, NW Sect 26-5N-10W (+ *)	(* +) 263' DF	(* +) 935'	N.D.	16" -- 40' 10" -- 830' (+)	NO 0' - 50' (+)	N.D.	Pulled 16" Csg (+)	-564' MSL (+)	N.A.	Anhydrite 832' Depth to bottom @ 935' Depth Sulphur Test (+)
Minsearch #1 Blackstrom (+ *)	P-96	320'S & 100'W NE Cor., NE, SW Sect 26-5N-10W (+ *)	(+ *) 217' DF	3000' (+ *)	SP-RESIS (8)	16" -- 36' (+)	NO (+)	N.D.	Pulled Casing (+)	N.A.	N.A.	No Domal Material Penetrated (+)
Exploco Corp #2 Masonite (* + 8)	P-76	606'N & 249'E SW Cor., SW Sect. 23-5N-10W 5N-10W (* + 8)	239' (+ *)	1065' (*) 1063' (+)	SP-RESIS (8)	16" -- 73' 10" -- 749' (+)	NO 0' - 50' (+)	N.C.	Salvaged 16" Csg (+)	-500' MSL (+)	N.A.	Note: Shale @ 753'-1047' Depth, Anhydrite @ 1047'-1063' Depth -Caprock Overhang? Sulphur Test (+)
DOE/Masonite MRIG-9	MRIG-9	1999.5' FNL 1017.2' FWL Sect 26-5N-10W	256.0' (RKB)	3275' (RKB)	Acoustilog Comp. Densilog Comp. Neutron Dual Ind.-Focused	13 3/4" -- 450' 9 5/8" -- 550.05'	0' - 450' 0' - 550.05'	550.05'	N.A.	-290' MSL/ 213' (RKB)	-511' MSL/ 500' (RKB)	Hole Bottomed In Salt at -1019' MSL
Exploco Corp. #2 Ridgway (* +)	P-90	1030'E & 600'N SW Cor. Sect. 34-5N-10W (+ *)	217' (+ *)	899' (+ *)	N.D.	16"--40' 10"--577' (+)	NO 0' - 50' (+)	N.D.	Pulled 16" Csg (+)	-561' MSL (+)	N.A.	Anhydrite 801' Depth to bottom @ 899' Depth Sulphur Test (+)
Minsearch B-4 Ridgway (+)	P-91	70'N & 600'E of SW Cor. NE, SE; Sect. 34-5N-10W (+)	255' (est)	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Minsearch B-10 Ridgway (* +)	P-92	500'S & 100'W of NE Cor., SW, NW Sect. 35-5N-10W (+ *)	(* +) 242' DF	(* +) 717'	N.D.	10"--506' (+)	0' - 50' (+)	N.D.	N.D.	-340' MSL (+ *)	N.A.	Anhydrite 619' Depth to bottom @ 717' Sulphur Test (+)
Exploco Corp. #1 Carter (* +)	P-93	660'N & 660'W of SE Cor., NW, SE; Sect. 35-5N-10W (+ *)	(+ *) 220' DF	(* +) 700'	N.D.	16"--80' 10"--536' (+)	NO 0' - 50' (+)	N.D.	Pulled 16" Csg (+)	-304' MSL (* +)	N.A.	Anhydrite 608' Depth to bottom @ 700' Depth Sulphur Test (+)

NOTES:

All dimensions are in feet

TABLE 12-2

(PAGE 5 OF 6)

BOREHOLE DATA SUMMARY
RICHTON DOME

WELL NAME	LETCO WELL NO.	LOCATION	ELEV. G. L.	TOTAL DEPTH	LOGS RUN	CASING DIA. (O.D.)--DEPTH	CEMENTING	CASING SEAT DEPTH	ABANDONMENT PROCEDURE	CAPROCK TOP/ THICKNESS PENETRATED	SALT TOP/ THICKNESS PENETRATED	REMARKS
Minsearch B-7 Ridgway (* +)	P-82	400'S & 300'W of NE Cor., SW SE Sect 27-5N-10W (* +)	(* *) 235' DF	(* *) 992'	N.D.	10"--518' (+)	N.D.	N.D.	N.D.	-297' (* *)	N.A.	Anhydrite @ 600' Depth to bottom of hole Sulphur Test (+)
Exploro Corp B-5 Ridgway (* *)	P-83	2500'E & 165'S of SW Cor., SW, NW 27-5N-10W (* *)	246' DF (* +)	683' (* *)	N.D.	10"--556' (+)	0' - 50' (+)	N.D.	N.D.	-389' (* *)	N.A.	Anhydrite @ 501' Depth to bottom of hole Sulphur Test (+)
Exploro Corp B-1 Ridgway (* *)	P-84	660'S & 660'W of NE Cor. Sect 27-5N-10W (* *)	(* *) 229' DF	(* *) 673'	N.D.	16"--40' 10"--523' (+)	No 0' - 50' (+)	N.D.	Pulled 16" Csg (+)	-300' MSL (+)	N.A.	Anhydrite @ 541' Depth to bottom of hole Sulphur Test (+)
Minsearch B-8 Ridgway (* +)	P-87	360'S & 300'W of NE Cor., SW, NE Sect 34-5N-10W (* *)	(* +) 217' DF	(* *) 775'	N.D.	10"--300' (+)	N.D.	N.D.	N.D.	-600' MSL/ 53' (* +)	-541' MSL (* *)	Anhydrite @ 751' - 758' Depth (7' Thick) Sulphur Test (+)
Minsearch #1 Smith (* *)	P-88	300'W of SE Cor. NW, SE Sect 34-5N-10W (* *)	(* *) 205' DF	(* *) 1090'	N.D.	16"--30' (+)	No	N.D.	Pulled Csg (+)	-645' MSL (* *)	N.A.	Anhydrite @ 950' Depth to bottom of hole Sulphur Test (+)
Exploro Corp. B-11 Ridgway (+)	P-77	400'N & 300'E of SE Cor., SW, NW Sect 26-5N-10W (+)	(+) 233' DF	(+) 640'	N.D.	10"--504' (+)	N.D.	N.D.	N.D.	-260' MSL (+)	N.A.	Anhydrite @ 533' Depth to bottom of hole (+)
Minsearch #1 Rich (* +)	P-78	300'N & 350'W of SE Cor., NE, SE Sect 26-5N-10W (+)	230' (*)	872' (*)	N.D.	16"--30' 10"--765' (+)	No No (+)	N.D.	Pulled all Csg (+)	-575' MSL (* *)	N.A.	Anhydrite 772' Depth - Bottom (Conflicting locations in Oil & Gas Bd. Records - vs - P.I. Records) Sulphur Test (+)
Exploro Corp. B-3 Ridgway (* +)	P-79	660'N & 1000'W of SE Cor., SW/4 Sect 26-5N-10W (* +)	253' DF (* *)	730' (* *)	N.D.	16"--40' 10"--329' (+)	No 0' - 50' (+)	N.D.	Pulled 16" Csg (+)	-330' MSL (* *)	N.A.	Anhydrite 630' Depth to bottom of hole Sulphur Test (+)
Exploro Corp #10 Hassmite (* +)	P-80	515'E & 300'S of SW Cor., SW,NE Sect 26-5N-10W (* *)	277' DF (* *)	753' (* *)	N.D.	10"--601' (+)	No	N.D.	Pulled Csg (+)	-320' MSL (* *)	N.A.	Anhydrite @ 610' Depth to bottom of hole Sulphur Test (+)
Minsearch B-6 Ridgway (* +)	P-81	160'S & 200'E of SW Cor., SW/4 Sect 27-5N-10W (* +)	(* *) 222' DF	765' (* +)	N.D.	10"--727' (+)	N.D.	N.D.	N.D.	-502' / 26' (* *)	-528' (* *)	Anhydrite @ 745' - 750' Depth (5' Thick) Sulphur Test (+)

NOTES:

All dimensions are in feet

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 12-2

(PAGE 6 OF 8)

RICHTON DOME
AVAILABLE DATA SUMMARY

WELL NAME	LATCO WELL NO.	LOCATION	ELEV. G. L.	TOTAL DEPTH	LOGS RUN	CASING DIA. (O.D.)--DEPTH	CEMENTING	CASING SEAT DEPTH	ABANDONMENT PROCEDURE	CAPROCK TOP/ THICKNESS PENETRATED	SALT TOP/ THICKNESS PENETRATED	REMARKS
Explore Corp. #1 Masonite (* *)	P-70	1100'S & 50'W of NE Cor. Sect 22-5N-10W (* *)	250' DF (* *)	856' (* *)	N.D.	16"--40' 10"--720' (*)	No 0' - 50' (*)	N.D.	Pulled 16" Csg (*)	-469' MSL/ 130' (* *)	-593' MSL (* *)	Anhydrite @ 763' Depth Bottoms in Salt @ 856' Depth Sulphur Test (*)
Explore Corp. #8 Masonite (* *)	P-71	600'S & 300'W of NE Cor., SE, SW Sect 22-5N-10W (* *)	267' DF (*)	765' (*)	N.D.	10"--670' (*)	No (*)	N.D.	Pulled Casing (*)	-411' MSL/ 102' (*)	-513' MSL (*)	Anhydrite @ 696' Depth (66' Thick) Bottoms in Salt @ 765' Depth Sulphur Test (*)
Explore Corp. #4 Masonite (* *)	P-72	506'E & 85'S of NW Cor., NE, SW Sect. 23-5N-10W (* *)	300' DF (* *)	771' (*) 772' (*)	N.D.	10"--750' (*)	0' - 50' (*)	N.D.	N.D.	Anhydrite -506' MSL/ 20' (*)	-526' MSL (* *)	Possible Caprock @ 780' (Sandy Lime & Sh) Bottoms in Salt Sulphur Test (*)
Explore Corp. #6 Masonite (* *)	P-73	203'N & 145'W of SE Cor., NW, SW Sect 23-5N-10W (* *)	282' DF (* *)	632' (* *)	N.D.	16"--40' 10"--531' (*)	No No (*)	N.D.	Pulled all Csg (*)	-307' MSL (*)	N.A.	Anhydrite @ 535' Depth to bottom @ 632' Depth (*)
Explore Corp. #5 Masonite (* *)	P-74	705'N & 292'W of SE Cor., SW, SE Sect 23-5N-10W (*)	233' DF (* *)	969' (*) 970' (*)	N.D.	10"--863' (*)	No (*)	N.D.	Pulled Csg	-638' MSL (*)	N.A.	Anhydrite @ 871' Depth to bottom of hole
Monsearch #1 Pope (* *)	P-52	354'S & 75'W of NE Cor., SW, SE Sect. 2-4N-10W (* *)	286' DF (*)	583' (* *)	N.D.	16"--60' 10"--560' (*)	No 0' - 50' (*)	N.D.	Pulled 16" Csg (*)	Anhydrite -362' MSL (*)	N.A.	BTM @ 583' Depth in Anhyd. Sulphur Test Well (*)
Monsearch #2 Carter (* *)	P-53	450'S & 100'W of NE Cor., SE, NE Sect 2-4N-10W (* *)	184' (*)	682' (*)	N.D.	16"--30' 10"-507' (*)	No No	N.D.	Pulled 10" Csg (*)	-383' MSL (*)	N.A.	Anhydrite 507' Depth to Btm @ 682' Depth Anhydrite Shows Faulting Sulphur Test (*)
Explore Corp. #9 Masonite (* *)	P-67	600'W & 50'N of SE Cor., SE, SW Sect. 22-5N-10W(*) Note: P.I. Gives 690'W & 50'N (*)	314' DF (*)	760' (* *)	N.D.	10"--714' (*)	No (*)	N.D.	Pulled Casing (*)	-398' MSL/ 24' (*)	-522' MSL to bottom of hole (*) (528'*)	Anhydrite 730' Depth (6' Thick) Well Bottoms in Salt Sulphur Test (*)
Explore Corp. #7 Masonite (* *)	P-68	800'S & 600'W of NE Cor., NE, SE Sect 22-5N-10W (* *)	214' DF (* *)	735' (* *)	N.D.	10"--651' (*)	0' - 50' (*)	N.D.	N.D.	-436' MSL/ 72' (*)	-508' MSL (* *)	Anhydrite @ 670' Depth (52' Thick) Bottoms in Salt Sulphur Test (*)
Explore Corp. #3 Masonite (* *)	P-69	100'N & 200'E of SW Cor. Sect 22-5N-10W (* *)	220' DF (* *)	739' (*) 740' (*)	N.D.	16"--40' 10"--657' (*)	No No (*)	N.D.	All Casing Pulled (*)	-407' MSL/ 102' (* *)	-509' MSL (* *)	Anhydrite @ 697' Depth (40' Thick) Bottoms in Salt @ 739' Depth Sulphur Test (*)

NOTES:

All dimensions are in feet

TABLE 12-2

(PAGE 7 OF 8)

BOREHOLE DATA SUMMARY
RICHTON DOME

WELL NAME	LETCO WELL NO.	LOCATION	ELEV. G.L.	TOTAL DEPTH	LOGS RUN	LOGS RUN	CASING DIA. (O.D.)--DEPTH	CEMENTING	CASING SEAT DEPTH	ABANDONMENT PROCEDURE	CAPROCK TOP/ THICKNESS PENETRATED	SALT TOP/ THICKNESS PENETRATED	REMARKS
Minosearch #1 Fisher (* *)	P-47	150'W & 100'N of SE Cor., SE, NW Sect. 1-4N-10W (* *)	225' From Topo Sheet	979' (* *)	N.D.	N.D.	16"--30' (*)	No (*)	N.D.	Casing Pulled (*)	-654' MSL/ To Bottom (Anhyd.) (*)	N.A.	Bottomed in Anhydrite Sulphur Test (*)
Minosearch #1 Carey (* *)	P-49	100'S & 100'E of NW Cor., NW, NE Sect. 1-4N-10W (* *)	235' From Topo Sheet	1312' (* *)	N.D.	N.D.	16"--30' (*)	No (*)	N.D.	Casing Pulled (*)	-955' MSL/ To Bottom (Anhyd)	N.A.	Bottomed in Anhydrite Top Anhydrite - 1212' Depth Sulphur Test (*)
Explorco Corp. #1 Carey (* *)	P-49A						SEE ABOVE						Tele Communication with Miss. State O. & G. BD indicates that this is a wash-over of P-49, Minosearch #1 Carey - No further data is available (8)
Minosearch A-12 Ridgeway (* *)	P-50	400'N & 150'W of SE Cor., NW, NW Sect. 2-4N-10W (* *)	234' (*)	873' (*)	N.D.	N.D.	10"--732' (*)	No (*)	N.D.	Casing Pulled	-606' MSL (*)	N.A.	Anhydrite @ 775' Depth BTM @ 873' (Depth) in Anhyd. Sulphur Test (*)
Minosearch #2 Pope (* *)	P-51	125'N & 102'W of SE Cor., NE, SE Sect. 2-4N-10W (*) Note: P.I. Lists 107'W (*) of SE Cor.	261' DF (*)	1591' (* *)	N.D.	N.D.	16"--40' 10"--1115' (*)	No 0' - 50' (*)	N.D.	N.D.	Anhydrite -830' MSL (*)	N.A.	Possible Caprock @ 1091' Depth (DRLR. Log) BTM @ 1591' (Depth) in Anhyd Sulphur Test (*)

NOTES:

All dimensions are in feet

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

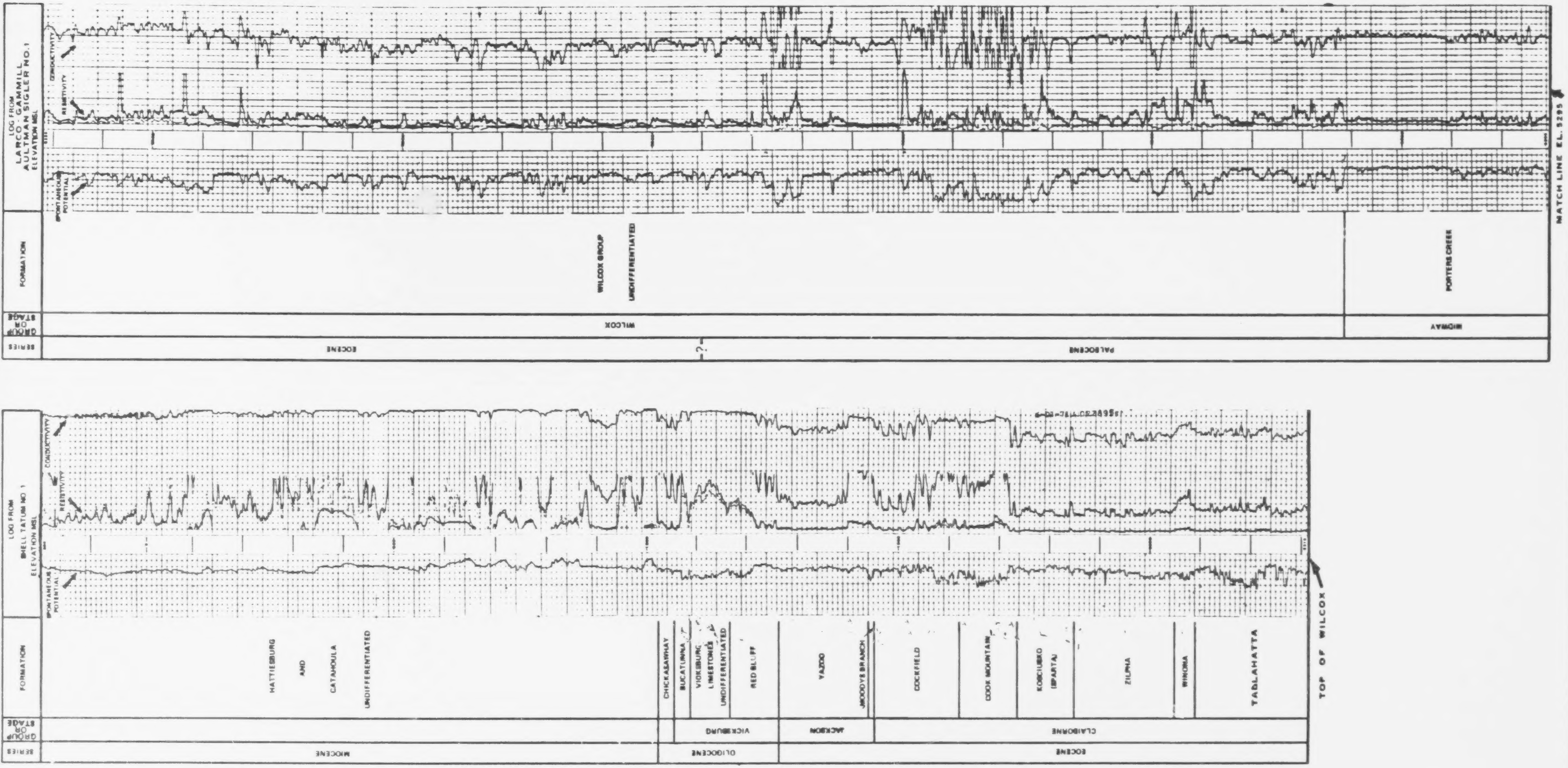
TABLE 12-2

(PAGE 8 OF 8)

BOREHOLE DATA SUMMARY

SYMBOLS USED TO DENOTE DATA SOURCES

+	Missippi State Oil & Gas Board Permits, Completion Records, etc.
X	Geophysical Logs
*	Petroleum Information Corp Completion Card
#	Telecommunications - Mississippi State Oil & Gas Board
N.A.	Not Applicable
N.D.	No Data



PREPARED	J.D.G.	DATE	5-30-80
REVISED	C.A.	DATE	6/4/81
REVISED		DATE	
APPROVED	JarlE	DATE	6/15/81

T-1240A-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

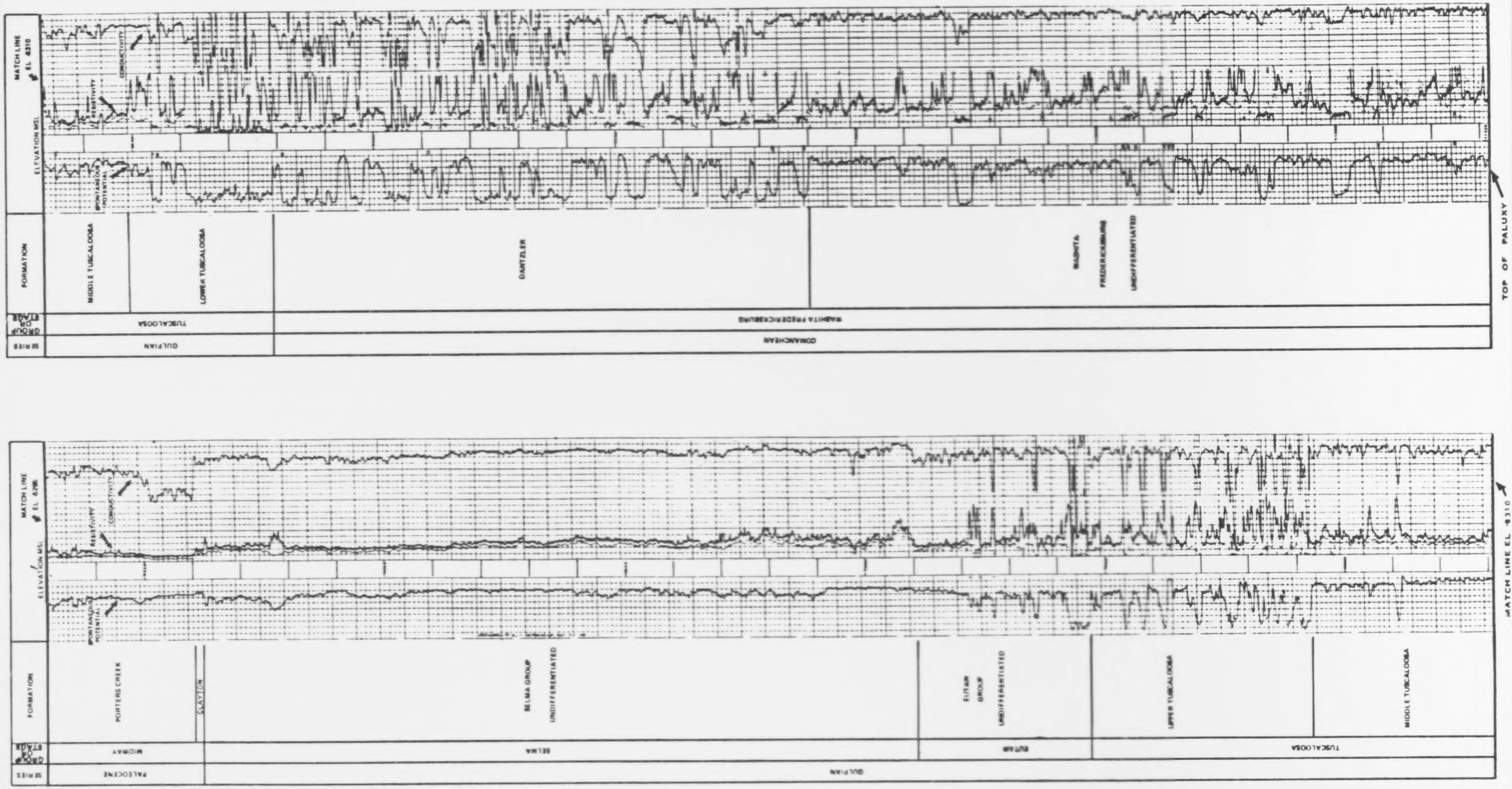
MISSISSIPPI STUDY AREA

TYPE GEOPHYSICAL LOG

JOB NO. MV9600

FIGURE 12-11
PAGE 1 OF 4

BEST DOCUMENT AVAILABLE



PREPARED J.D.G. DATE 5-30-80
REVISED DATE
REVISED DATE
APPROVED DATE
T-1240B-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

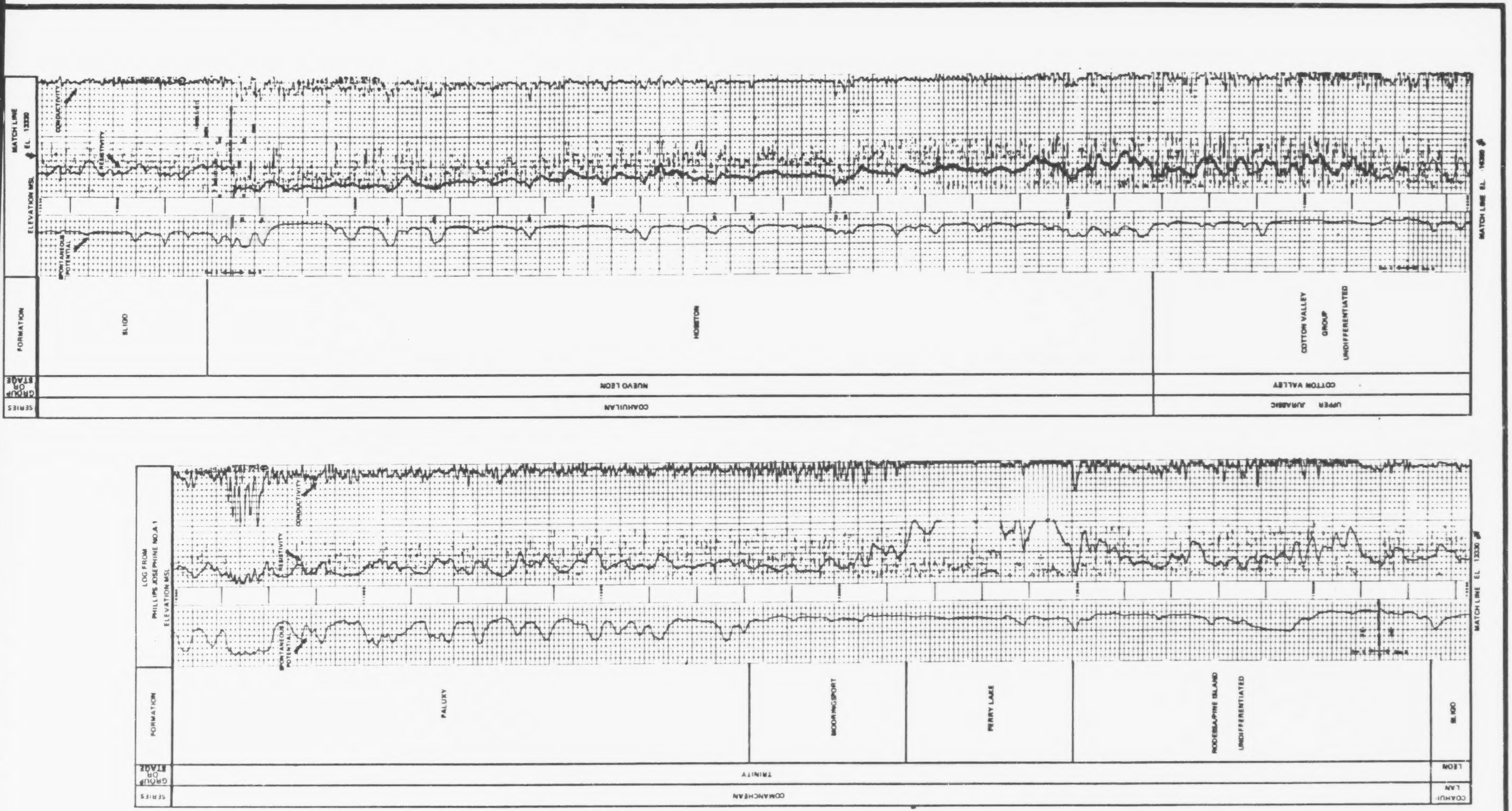
MISSISSIPPI STUDY AREA

TYPE GEOPHYSICAL LOG

JOB NO MV9600

FIGURE 12-11
PAGE 2 OF 4

BEST DOCUMENT AVAILABLE



PREPARED ____ DATE 5-30-80
REVISED ____ DATE 1-14-81
REVISED ____ DATE ____
APPROVED ____ DATE 8/12/80

T-1240C-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

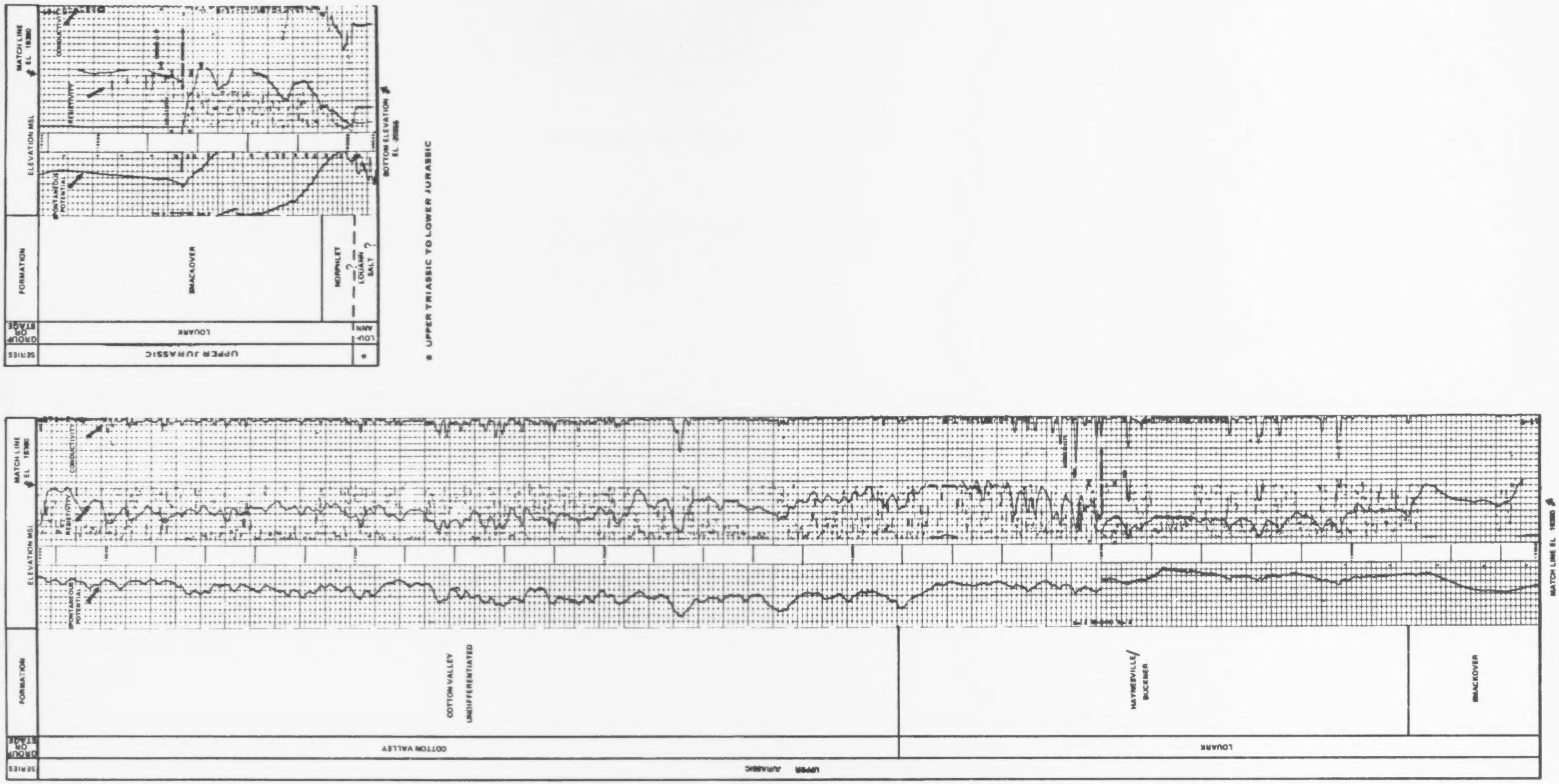
MISSISSIPPI STUDY AREA

TYPE GEOPHYSICAL LOG

JOB NO. MV9600

FIGURE 12-11
PAGE 3 OF 4

BEST DOCUMENT AVAILABLE



* UPPER TRIASSIC TO LOWER JURASSIC

PREPARED *ADG* DATE *5-30-80*
REVISED *DS* DATE *1-7-81*
REVISED DATE
APPROVED DATE *8/15/80*

T-1240D-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

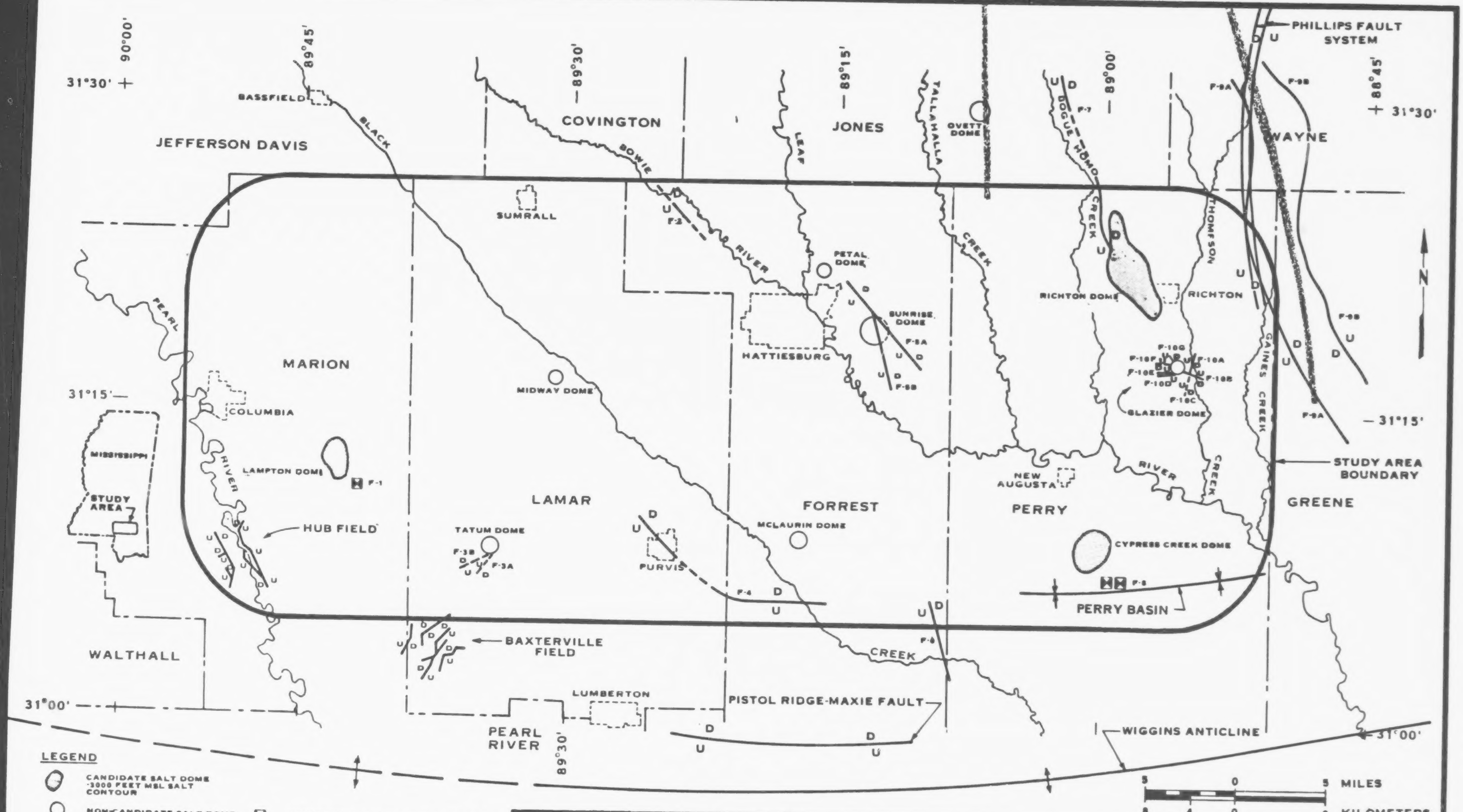
TYPE GEOPHYSICAL LOG

JOB NO. MV9600

FIGURE 12-11
PAGE 4 OF 4

BEST DOCUMENT AVAILABLE

34


90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
31°15'
31°00'
PHILLIPS FAULT SYSTEM
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
BLACK
BOWIE
LEAF
TALLAHALLA
OVETT DOME
BOGUE HOMO
F-7
F-9A
F-9B
SUMRALL
F-2
RIVER
CREEK
PETAL DOME
SUNRISE DOME
F-5A
F-5B
HATTIESBURG
RICHTON DOME
RICHTON
THOMPSON
GAINES CREEK
N
PEARL
MARION
COLUMBIA
MIDWAY DOME
F-10A
F-10B
F-10C
F-10D
F-10E
F-10F
F-10G
GLAZIER DOME
MISSISSIPPI
STUDY AREA
LAMPTON DOME
F-1
LAMAR
FORREST
NEW AUGUSTA
PERRY
GREENE
STUDY AREA BOUNDARY
HUB FIELD
TATUM DOME
F-3A
F-3B
PURVIS
McLAURIN DOME
CYPRESS CREEK DOME
F-4
F-6
F-8
PERRY BASIN
WALTHALL
BAXTERVILLE FIELD
LUMBERTON
PISTOL RIDGE-MAXIE FAULT
PEARL RIVER
WIGGINS ANTICLINE
U
D
5 0 5 MILES
8 4 0 8 KILOMETERS

LEGEND

- CANDIDATE SALT DOME -3000 FEET MSL SALT CONTOUR
- NON-CANDIDATE SALT DOME
- SYNCLINAL AXIS
- ANTICLINAL AXIS, DASHED WHERE INFERRED
- COUNTY LINE
- FAULT ZONE - SEE SECTION 12.2.3.4.5.1
- FAULT ZONE - SEE SECTION 12.2.3.4.5.2
- NORMAL FAULT, DASHED WHERE INFERRED
- FAULT NUMBER REFERENCED IN TEXT.
- SALT ANTICLINE

PREPARED	J.D.G.	DATE	5-30-80
REVISED		DATE	12/4/81
REVISED		DATE	
APPROVED		DATE	3/10/82

T-1253-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

STRUCTURAL FEATURES

JOB NO. MV9600

FIGURE 12-12

BEST DOCUMENT AVAILABLE

piercement salt domes of the Mississippi Salt Basin (Oxley and others, 1968).

12.2.2.1.2 Upper Jurassic Series - The Upper Jurassic Series includes the Louark and Cotton Valley Groups.

12.2.2.1.2.1 Louark Group: The Louark Group consists of the Norphlet, Smackover, and Haynesville-Buckner Formations, which were deposited in near-shore to open marine environments and include some eolian and restricted marine deposits (Rainwater, 1963; Badon, 1975). All three formations in the Louark Group, which together range in thickness from 457 to 1,052 meters (1,500 to 3,450 ft), have produced hydrocarbons in Mississippi. The Norphlet Formation, consisting of poorly sorted, shaley sandstones and sandy shales, unconformably overlies the Louann Group and is itself conformably overlain by the Smackover Formation, a distinctive sequence of dense and finely crystalline limestones and dolomites. The Haynesville-Buckner Formation, which conformably overlies the Smackover, consists of dense, lithographic limestones with minor amounts of interbedded anhydrite and dolomitic carbonates (Dinkins, 1968).

12.2.2.1.2.2 Cotton Valley Group: The Cotton Valley Group, undifferentiated, is a sequence of fine to medium-grain sandstones alternating with mudstones and shales (Dinkins, 1968). The unit, which is a marine deltaic deposit ranging in thickness from 610 to 884 meters (2,000 to 2,900 ft), is important for hydrocarbon production north of the Mississippi Study Area (Mississippi State Oil and Gas Board, 1978). The Cotton Valley Group conformably overlies the Haynesville-Buckner Formation and is unconformably overlain by the Hosston Formation.

12.2.2.2 Cretaceous System: The Cretaceous System includes the Lower Cretaceous Coahuilan and Comanchean Series, and the Upper Cretaceous Gulfian Series.

12.2.2.2.1 Lower Cretaceous Coahuilan Series - The Coahuilan Series consists of the Nuevo Leon Group.

12.2.2.2.1.1 Nuevo Leon Group: The Nuevo Leon Group includes the Hosston and Sligo Formations, which are composed of deltaic and marine deposits (Williams, 1967; Rainwater, 1963). The Hosston Formation consists of 549 to 808 meters (1,800 to 2,650 ft) of very fine to coarse-grain sandstone, sandy shale and sandy, lignitic mudstone (Nunnally and Fowler, 1954). The Hosston Formation contains hydrocarbon-producing zones (Mississippi State Oil and Gas Board, 1977). The Sligo Formation conformably overlies the Hosston Formation (Bicker, 1966) and consists of approximately 91 meters (300 ft) of fine to medium-grain sandstone interbedded with splintery shales and nodular limestones (Dinkins, 1967). Hydrocarbon production is known in the Sligo Formation north of the Mississippii Study Area (Mississippi State Oil and Gas Board, 1978).

12.2.2.2.2 Lower Cretaceous Comanchean Series - The Comanchean Series includes the Trinity, Fredericksburg, and Washita Groups.

12.2.2.2.2.1 Trinity Group: The Trinity Group is divided into the Glen Rose Subgroup and the Paluxy Formation and consists of terrestrial to shallow-marine sequences (Rainwater, 1963). These sediments range up to 1,158 meters (3,800 ft) thick in southwestern Mississippi (Childress, 1973). The Glen Rose Subgroup includes the Pine Island, Rodessa, Ferry Lake, and Mooringsport Formations.

The Rodessa-Pine Island unit consists of 229 meters (750 ft) of shales, very fine to fine-grain sandstones and siltstones, and pseudo-oolitic limestones with an overlying thin anhydrite stringer. This sequence cannot be differentiated on electrical logs from wells in the study area. The Rodessa-Pine Island unit conformably overlies the Sligo Formation (Dinkins, 1967). Hydrocarbon production has been developed from the unit in Mississippi, but not within the study area (Mississippi State Oil and Gas Board, 1978).

The Ferry Lake Formation conformably overlies the Rodessa-Pine Island sequence. It is 49 to 73 meters (160 to 240 ft) thick and consists of shales alternating with oolitic or fossiliferous limestones and anhydrite (Nunnally and Fowler, 1954).

The Mooringsport Formation consists of 61 to 305 meters (200 to 1,000 ft) of limy shales alternating with mudstones, silty sandstones, and anhydrite-bearing limestones. It conformably overlies the Ferry Lake Formation (Nunnally and Fowler, 1954).

Hydrocarbon production has been developed within the Mississippi Study Area from portions of the Mooringsport Formation (Mississippi State Oil and Gas Board, 1978).

The Paluxy Formation conformably overlies the Glen Rose Subgroup and is a hydrocarbon producer. The Paluxy Formation consists of 305 to 442 meters (1,000 to 1,450 ft) of fissile shales, lignitic mudstones, and carbonaceous sandstones (Nunnally and Fowler, 1954; Mississippi State Oil and Gas Board, 1977).

12.2.2.2.2.2 Fredericksburg and Washita Groups: The Fredericksburg and Washita Groups include the undifferentiated Washita-Fredericksburg unit and the Dantzler Formation. They range from terrestrial to restricted shallow-marine to carbonate shelf deposits (Rainwater, 1963). Both the Washita-Fredericksburg and the Dantzler units are hydrocarbon reservoirs in the state (Mississippi State Oil and Gas Board, 1977). The Washita-Fredericksburg unit consists of 305 to 573 meters (1,000 to 1,880 ft) of interbedded silty mudstones, shales, carbonaceous sandstones, and limestones (Nunnally and Fowler, 1954); the sequence conformably overlies the Paluxy Formation of the Trinity Group. The Dantzler Formation, which ranges from 175 to 351 meters (575 to 1,150 ft) thick, consists of shales, mudstones, nodular limestones, and lignitic sandstones (Nunnally and Fowler, 1954). The Dantzler Formation conformably overlies the Washita-Fredericksburg unit (Nunnally and Fowler, 1954).

12.2.2.2.3 Upper Cretaceous Gulfian Series - The Gulfian Series includes the Tuscaloosa, Eutaw, and Selma Groups.

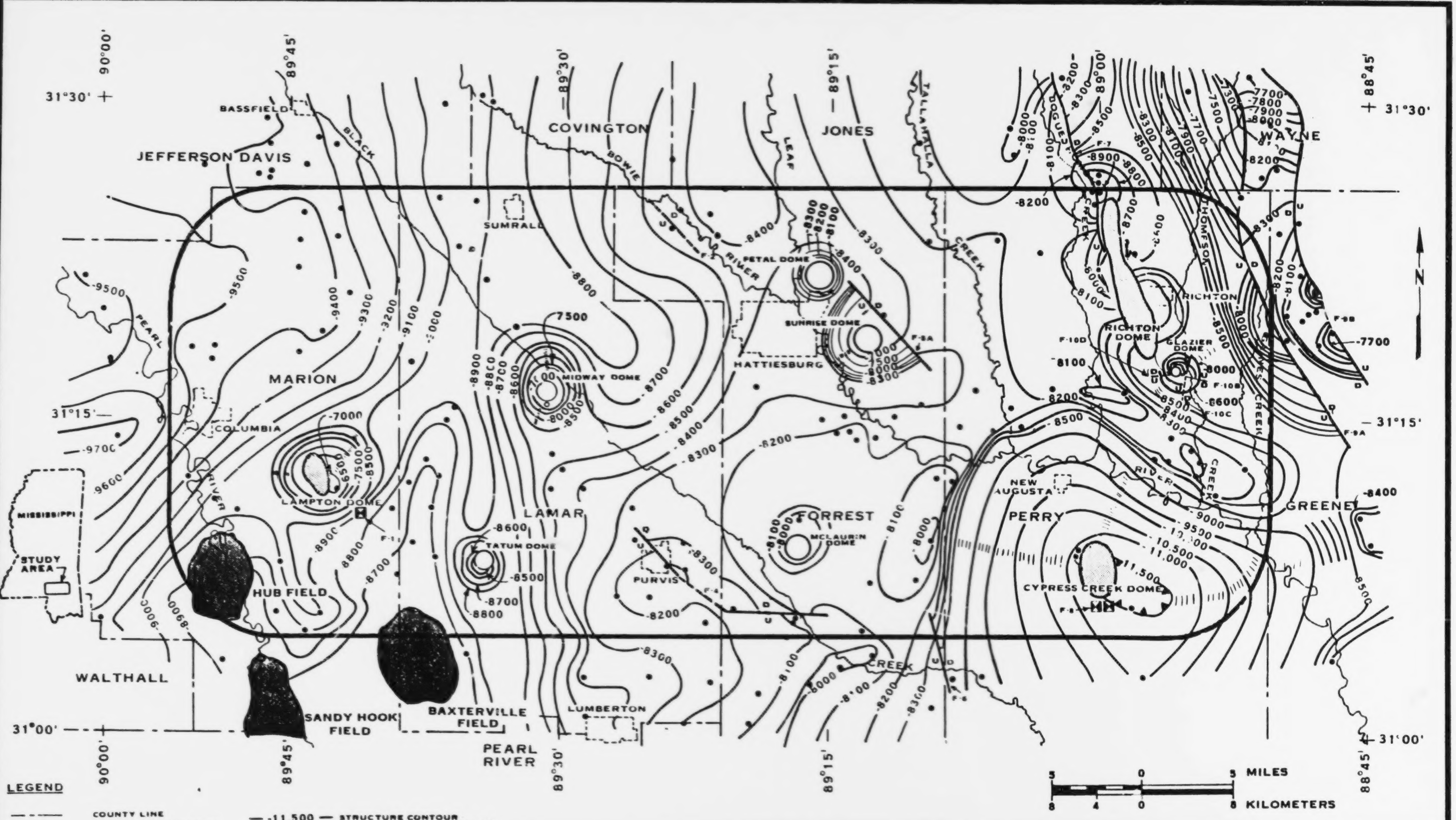
12.2.2.2.3.1 Tuscaloosa Group: The Tuscaloosa Group consists of the Lower, Middle, and Upper Tuscaloosa Formations, which are predominantly deltaic, restricted marine and terrestrial deposits (Rainwater, 1963). Petroliferous zones occur in the Lower and Upper Tuscaloosa Formations (Mississippi State Oil and Gas Board, 1977). The interpreted structure on top of the Lower Tuscaloosa Formation is shown in Figure 12-13 and is discussed in Section 12.2.3. The Lower Tuscaloosa Formation consists of fissile shales alternating with sandstones and siltstones (Dinkins, 1967). A basal massive sandstone occurs in the Lower Tuscaloosa Formation and rests unconformably on the underlying Dantzler Formation. The Middle Tuscaloosa Formation consists of carbonaceous shales interbedded with mudstones, sandstones, and siltstones (Dinkins, 1967). It conformably overlies the Lower Tuscaloosa Formation and, occasionally, includes a basal chalk or chalky limestone unit. The combined Middle and Lower Tuscaloosa Formations range in total thickness from 189 to 354 meters (620 to 1,160 ft) and the Upper Tuscaloosa Formation is 91 to 274 meters (300 to 900 ft) thick. The Upper Tuscaloosa Formation, which conformably overlies the Middle Tuscaloosa Formation, consists of fissile shales, mudstones, and porous sandstones (Dinkins, 1967; Mellen, 1959).

12.2.2.2.3.2 Eutaw Group: The Eutaw Group consists of shallow marine and deltaic deposits (Rainwater, 1963) and is not subdivided in the study area. The Eutaw Group is composed of interbedded lignitic shales, fine-grain sandstones, and calcareous siltstones which unconformably overlie the Tuscaloosa Group (Stephenson and Monroe, 1940). Petroliferous sandstones in the Eutaw Group are productive in a number of fields in Mississippi (Mississippi State Oil and Gas Board, 1977). In northeastern Mississippi the Eutaw is an important source of bentonite (Bicker, 1970).

12.2.2.2.3.3 Selma Group: The Selma Group, consisting of shallow and open marine deposits (Rainwater, 1963), is not subdivided in the study area. The Selma and Eutaw Groups together include from 282 to 457 meters (925 to 1,500 ft) of strata. Figure 12-14 is a structure contour map of the top of the Selma Group. The Selma Group is composed of a chalk and fissile shale sequence which conformably overlies the Eutaw Group (Dinkins, 1967). Some of the fractured Selma chalks produce hydrocarbons (Mississippi State Oil and Gas Board, 1977).

12.2.2.3 Tertiary System: The Tertiary System includes the Paleocene, Eocene, Oligocene, Miocene, and Plio-Miocene Series.

12.2.2.3.1 Paleocene Series - The Paleocene Series includes the Midway Group and the lowermost portion of the Wilcox Group.


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
SUMRALL
HATTIESBURG
COLUMBIA
NEW AUGUSTA
PURVIS
LUMBERTON
RICHTON
BLACK
BOWIE
LEAF
TALLAHALLA
RIVER
CREEK
PEARL
PETAL DOME
SUNRISE DOME
MIDWAY DOME
LAMPTON DOME
TATUM DOME
McLAURIN DOME
RICHTON DOME
GLAZIER DOME
CYPRESS CREEK DOME
HUB FIELD
SANDY HOOK FIELD
BAXTERVILLE FIELD
MISSISSIPPI
STUDY AREA
N
F-1
F-4
F-6
F-7
F-8
F-8A
F-9A
F-9B
F-10B
F-10C
F-10D
-7000
-7500
-7700
-7800
-7900
-8000
-8100
-8200
-8300
-8400
-8500
-8600
-8700
-8800
-8900
-9000
-9100
-9200
-9300
-9400
-9500
-9600
-9700
-10,500
-11,000
-11,500
5 0 5 MILES
8 4 0 8 KILOMETERS

LEGEND

— - —	COUNTY LINE	— -11,500 —	STRUCTURE CONTOUR SHOWS ELEVATION OF TOP OF LOWER TUSCALOOSA FORMATION. INTERVAL 100 FEET. DATUM IS MEAN SEA LEVEL.
⬭	CANDIDATE SALT DOME OUTLINE	$\overset{U}{\underset{D}{—}}$	NORMAL FAULT DASHED WHERE INFERRED
◜	NON CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED	F-4	FAULT NUMBER REFERENCED IN TEXT
⬬	OIL & GAS FIELD	⊠	FAULT ZONE - SEE SECTION 12.2.3.4.5.1
●	EXPLORATION WELL	⊠⊠	FAULT ZONE - SEE SECTION 12.2.3.4.5.6
○	AREA CHARACTERIZATION BORING		
▲▲-9000 ▲	CLOSED STRUCTURAL LOW		

PREPARED	J.D.G.	DATE	5-30-80
REVISED	1	DATE	
REVISED		DATE	
APPROVED		DATE	

T-1241-1

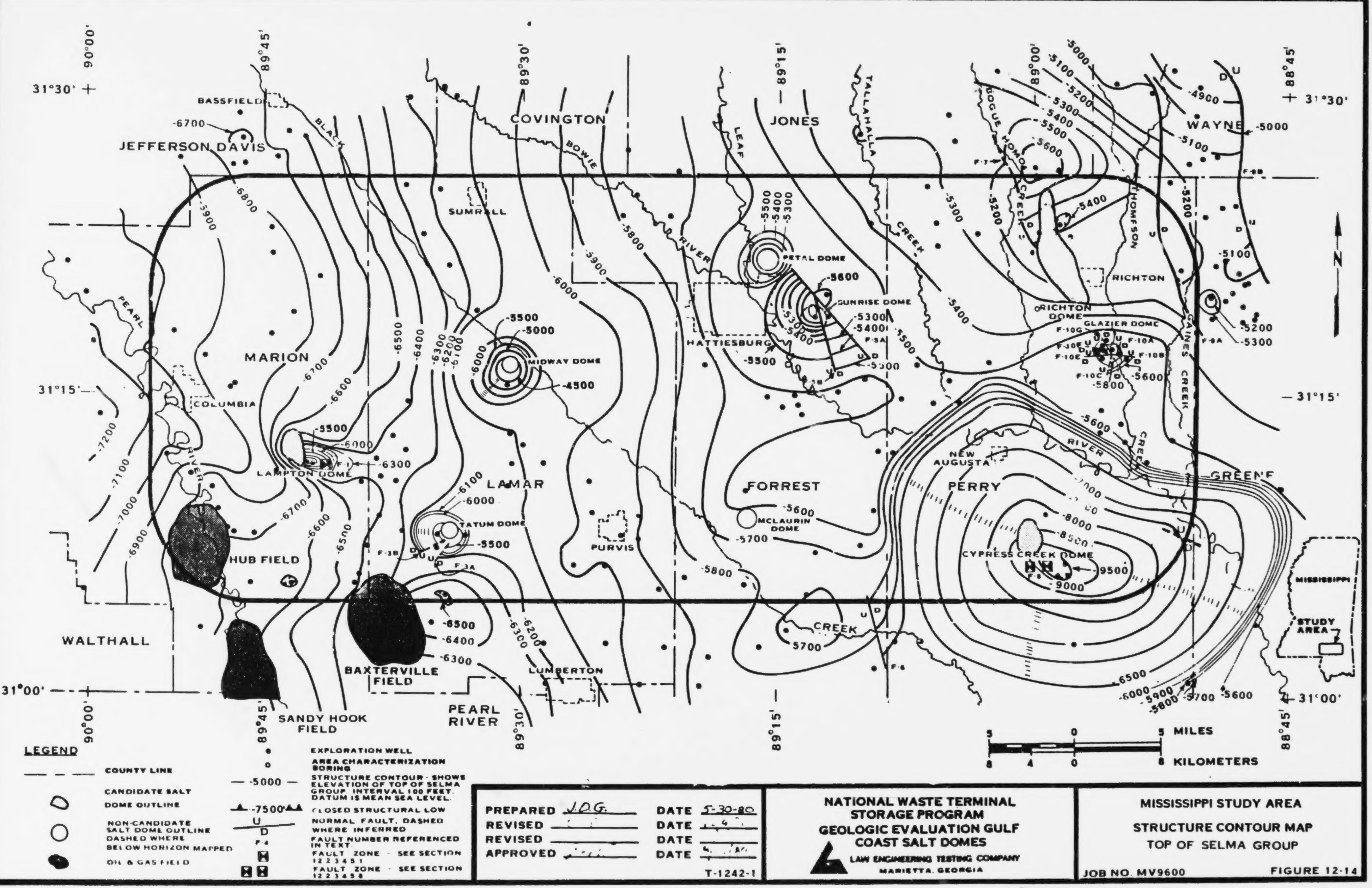
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
STRUCTURE CONTOUR MAP
TOP OF LOWER TUSCALOOSA FORMATION

JOB NO. MV9600

FIGURE 12-13

BEST DOCUMENT AVAILABLE


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
SUMRALL
COLUMBIA
HATTIESBURG
PURVIS
LUMBERTON
RICHTON
NEW AUGUSTA
PETAL DOME
SUNRISE DOME
MIDWAY DOME
LAMPTON DOME
TATUM DOME
MCLAURIN DOME
RICHTON DOME
GLAZIER DOME
CYPRESS CREEK DOME
HUB FIELD
BAXTERVILLE FIELD
SANDY HOOK FIELD
PEARL RIVER
BLACK CREEK
BOWIE RIVER
LEAF RIVER
TALLAHALLA CREEK
BOGUE HOMO CREEK
THOMPSON CREEK
GAINES CREEK
-4500
-4900
-5000
-5100
-5200
-5300
-5400
-5500
-5600
-5700
-5800
-5900
-6000
-6100
-6200
-6300
-6400
-6500
-6600
-6700
-6800
-6900
-7000
-7100
-7200
-8000
-8500
-9000
-9500
F-1
F-3A
F-3B
F-5A
F-6
F-7
F-8
F-9A
F-9B
F-10A
F-10B
F-10C
F-10D
F-10E
F-10F
F-10G
N
MISSISSIPPI
STUDY AREA
5 0 5 MILES
8 4 0 8 KILOMETERS
LEGEND
COUNTY LINE
CANDIDATE SALT DOME OUTLINE
NON-CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
OIL & GAS FIELD
EXPLORATION WELL
AREA CHARACTERIZATION BORING
-5000 STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF SELMA GROUP. INTERVAL 100 FEET. DATUM IS MEAN SEA LEVEL.
-7500 CLOSED STRUCTURAL LOW
U D NORMAL FAULT, DASHED WHERE INFERRED
F-4 FAULT NUMBER REFERENCED IN TEXT.
FAULT ZONE - SEE SECTION 12.2.3.4.5.1
FAULT ZONE - SEE SECTION 12.2.3.4.5.8

PREPARED J.D.G. DATE 5-30-80
REVISED DATE
REVISED DATE
APPROVED DATE

T-1242-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
STRUCTURE CONTOUR MAP
TOP OF SELMA GROUP

JOB NO. MV9600

FIGURE 12-14

BEST DOCUMENT AVAILABLE

Deposition of the Wilcox Group was continuous from the Paleocene into early Eocene time.

12.2.2.3.1.1 Midway Group: The Midway Group consists of the Clayton and Porters Creek Formations, which are deposits of inner neritic and restricted marine environments (Rainwater, 1964). The Clayton consists of 3 to 8 meters (10 to 25 ft) of sandy marls, marly chalks or calcareous clays (Rainwater, 1964). It overlies the Selma Group unconformably, produces hydrocarbons, and is gradational with the overlying Porters Creek Formation (Dinkins, 1966). The Porters Creek Formation consists of a 198 to 320-meter (650 to 1,050-ft)-thick sequence of interbedded shales, thin lignites, silts, siltstones, and fine-grain sandstones (Rainwater, 1964; Murray, 1979). Area Characterization data from the study area indicate that the ranges of thicknesses of the Clayton and Porters Creek Formations are from 0 to 11 meters (0 to 37 ft) and 143 to 364 meters (468 to 1,195 ft), respectively. Figure 12-15 is a structure contour map of the Porters Creek Formation.

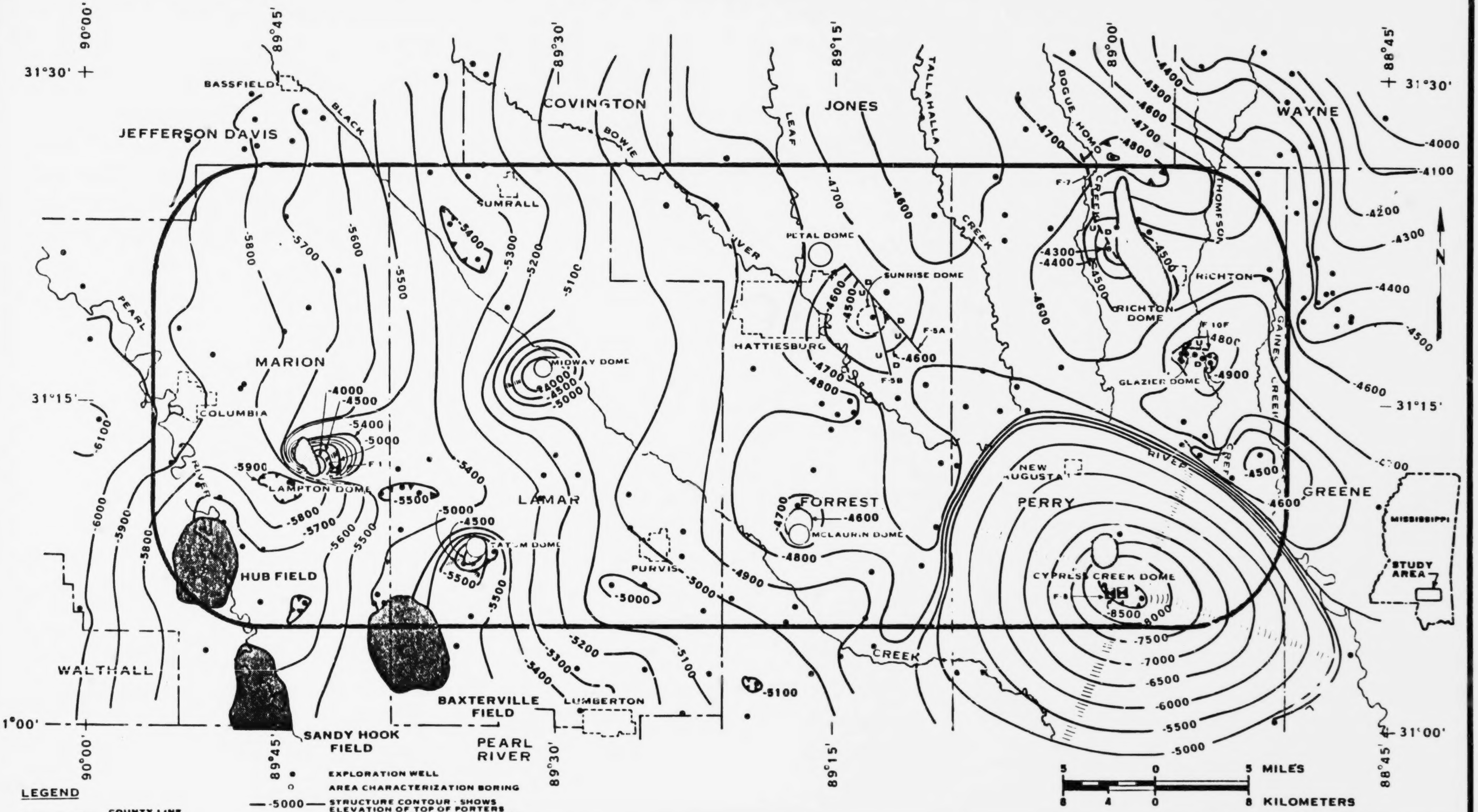
12.2.2.3.1.2 Wilcox Group: Regionally, the Wilcox Group consists of 686 to 975 meters (2,250 to 3,200 ft) of deltaic interbedded silts, sand, lignitic shales, siltstones, and sandstones which conformably overlie the Midway Group (Dinkins, 1967). The structure on the top of the Wilcox is shown in Figure 12-16 and the thickness distribution of the undifferentiated Wilcox Group is shown in Figure 12-21. In the study area, the

Wilcox is 568 to 1,510 meters (1,865 to 4,955 ft) thick. Mineral resources of the Wilcox Group include lignite and petroleum (Bicker, 1970; Mississippi State Oil and Gas Board, 1977).

12.2.2.3.2 Eocene Series - The Eocene Series includes a portion of the Wilcox Group as well as the Claiborne and Jackson Groups.

12.2.2.3.2.1 Claiborne Group: The Claiborne Group includes the Meridian, Tallahatta, Winona, Zilpha, Kosciusko (Sparta), Cook Mountain, and Cockfield Formations, which are deltaic, shallow-water, restricted marine deposits (Rainwater, 1963). The Claiborne Group is as much as 518 meters (1,700 ft) in overall thickness (Childress, 1973). Claiborne hydrocarbon production is known in southwestern Mississippi from the Kosciusko Formation and in central Mississippi from the Cockfield Formation (Mississippi State Oil and Gas Board, 1978). Regionally, the basal Meridian Formation consists of 15 to 27 meters (49 to 90 ft) of crossbedded sands which contain sandy shales and lignitic clays (Mississippi Geological Society, 1960). However, in the study area, the Meridian Formation cannot be differentiated from the overlying Tallahatta Formation. The Meridian Formation unconformably overlies the Wilcox Group.

The Tallahatta Formation is characterized as a limy silt-stone, claystone, and clay shale sequence (Williams, 1967), which is 39 to 152 meters (127 to 500 ft) thick in the study area, conformably overlying the Meridian Formation (Parks and other, 1963). The Winona Formation, consisting of clay shales which


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
BLACK
BOWIE
LEAF
TALLAHALLA
CREEK
RIVER
PEARL
BOGUE HOMO
THOMPSON
GAINES CREEK
SUMRALL
PETAL DOME
SUNRISE DOME
HATTIESBURG
RICHTON
RICHTON DOME
GLAZIER DOME
MIDWAY DOME
COLUMBIA
LAMPTON DOME
TATUM DOME
PURVIS
McLAURIN DOME
NEW AUGUSTA
CYPRESS CREEK DOME
HUB FIELD
BAXTERVILLE FIELD
SANDY HOOK FIELD
LUMBERTON
F-7
F-5A
F-5B
F-10F
F-1
F-8
-4000
-4100
-4200
-4300
-4400
-4500
-4600
-4700
-4800
-4900
-5000
-5100
-5200
-5300
-5400
-5500
-5600
-5700
-5800
-5900
-6000
-6100
-6500
-7000
-7500
-8000
-8500
MISSISSIPPI
STUDY AREA
N
5 0 5 MILES
8 4 0 8 KILOMETERS

LEGEND

— - —	COUNTY LINE
⬭	CANDIDATE SALT DOME OUTLINE
○	NON CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
●	OIL & GAS FIELD
•	EXPLORATION WELL
∘	AREA CHARACTERIZATION BORING
—-5000—	STRUCTURE CONTOUR · SHOWS ELEVATION OF TOP OF PORTERS CREEK FORMATION INTERVAL 100 FEET DATUM IS MEAN SEA LEVEL
▲▲ -5500 ▲▲	CLOSED STRUCTURAL LOW
U/D	NORMAL FAULT DASHED WHERE INFERRED
F 4	FAULT NUMBER REFERENCED IN TEXT
H	FAULT ZONE · SEE SECTION 12.2.3.4.5.1
HH	FAULT ZONE · SEE SECTION 12.2.3.4.5.8

PREPARED J.D.G. DATE 5-30-80
REVISED DATE
REVISED DATE
APPROVED DATE
T-1243-1

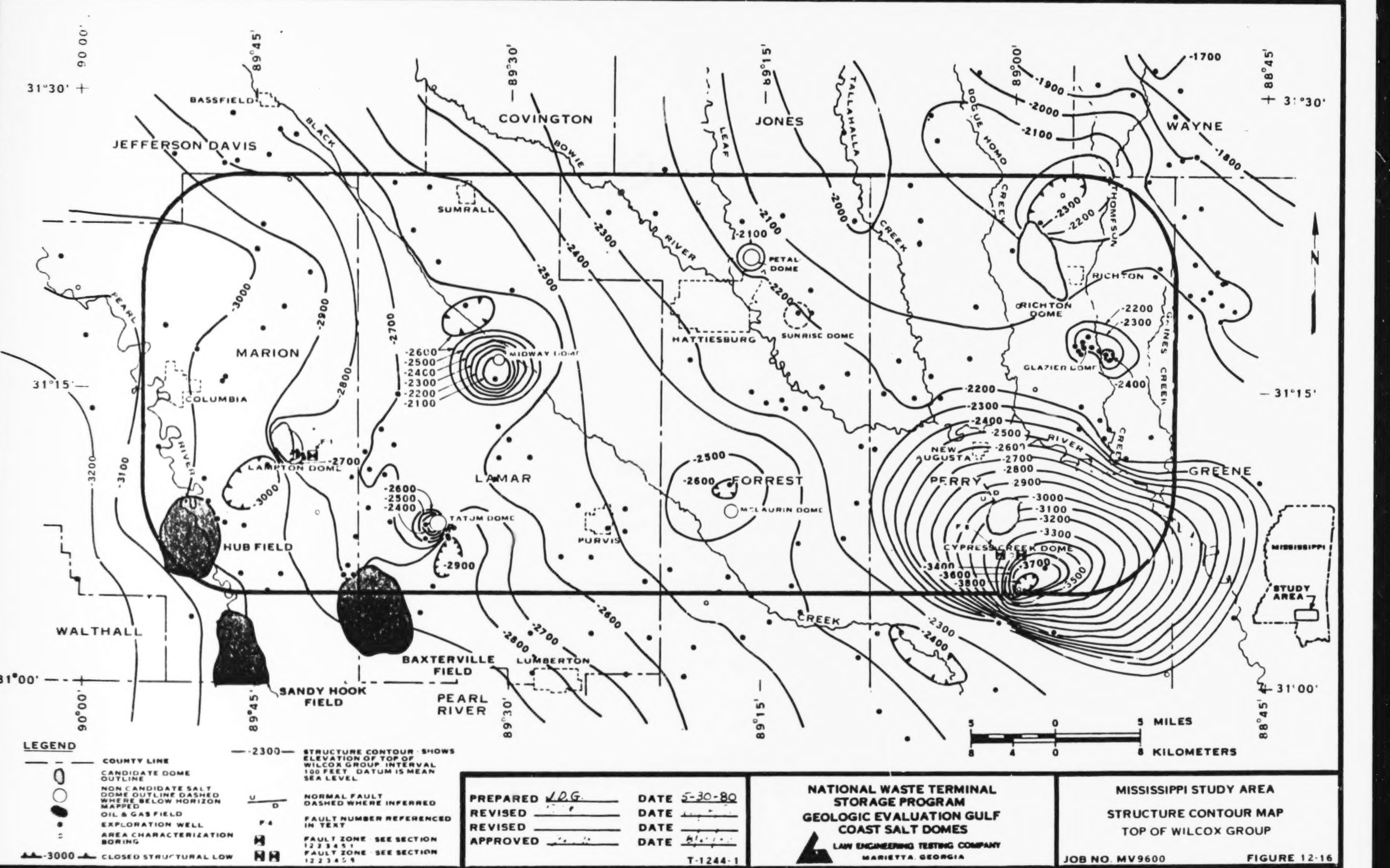
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
STRUCTURE CONTOUR MAP
TOP OF PORTERS CREEK FORMATION

JOB NO. MV9600
FIGURE 12-15

46

BEST DOCUMENT AVAILABLE


90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
SUMRALL
MARION
COLUMBIA
LAMPTON DOME
HUB FIELD
WALTHALL
SANDY HOOK FIELD
BAXTERVILLE FIELD
PEARL RIVER
LUMBERTON
LAMAR
MIDWAY DOME
TATUM DOME
PURVIS
FORREST
MCLAURIN DOME
HATTIESBURG
PETAL DOME
SUNRISE DOME
RICHTON
RICHTON DOME
GLAZIER DOME
NEW AUGUSTA
PERRY
CYPRESS CREEK DOME
GREENE
PEARL RIVER
BLACK
BOWIE
RIVER
LEAF
TALLAHALLA
CREEK
BOGUE HOMO CREEK
THOMPSON
GAINES CREEK
MISSISSIPPI
STUDY AREA
N
-1700
-1800
-1900
-2000
-2100
-2200
-2300
-2400
-2500
-2600
-2700
-2800
-2900
-3000
-3100
-3200
-3300
-3400
-3500
-3600
-3700
-3800
5 0 5 MILES
8 4 0 8 KILOMETERS
LEGEND
COUNTY LINE
CANDIDATE DOME OUTLINE
NON CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
OIL & GAS FIELD
EXPLORATION WELL
AREA CHARACTERIZATION BORING
-3000 CLOSED STRUCTURAL LOW
-2300 STRUCTURE CONTOUR SHOWS ELEVATION OF TOP OF WILCOX GROUP. INTERVAL 100 FEET. DATUM IS MEAN SEA LEVEL.
U D NORMAL FAULT DASHED WHERE INFERRED
F4 FAULT NUMBER REFERENCED IN TEXT
FAULT ZONE SEE SECTION 1 2 2 3 4 5 1
FAULT ZONE SEE SECTION 1 2 2 3 4 5 9

PREPARED J.D.G. DATE 5-30-80
REVISED DATE
REVISED DATE
APPROVED DATE
T-1244-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

STRUCTURE CONTOUR MAP
TOP OF WILCOX GROUP

JOB NO. MV9600 FIGURE 12-16

47

BEST DOCUMENT AVAILABLE

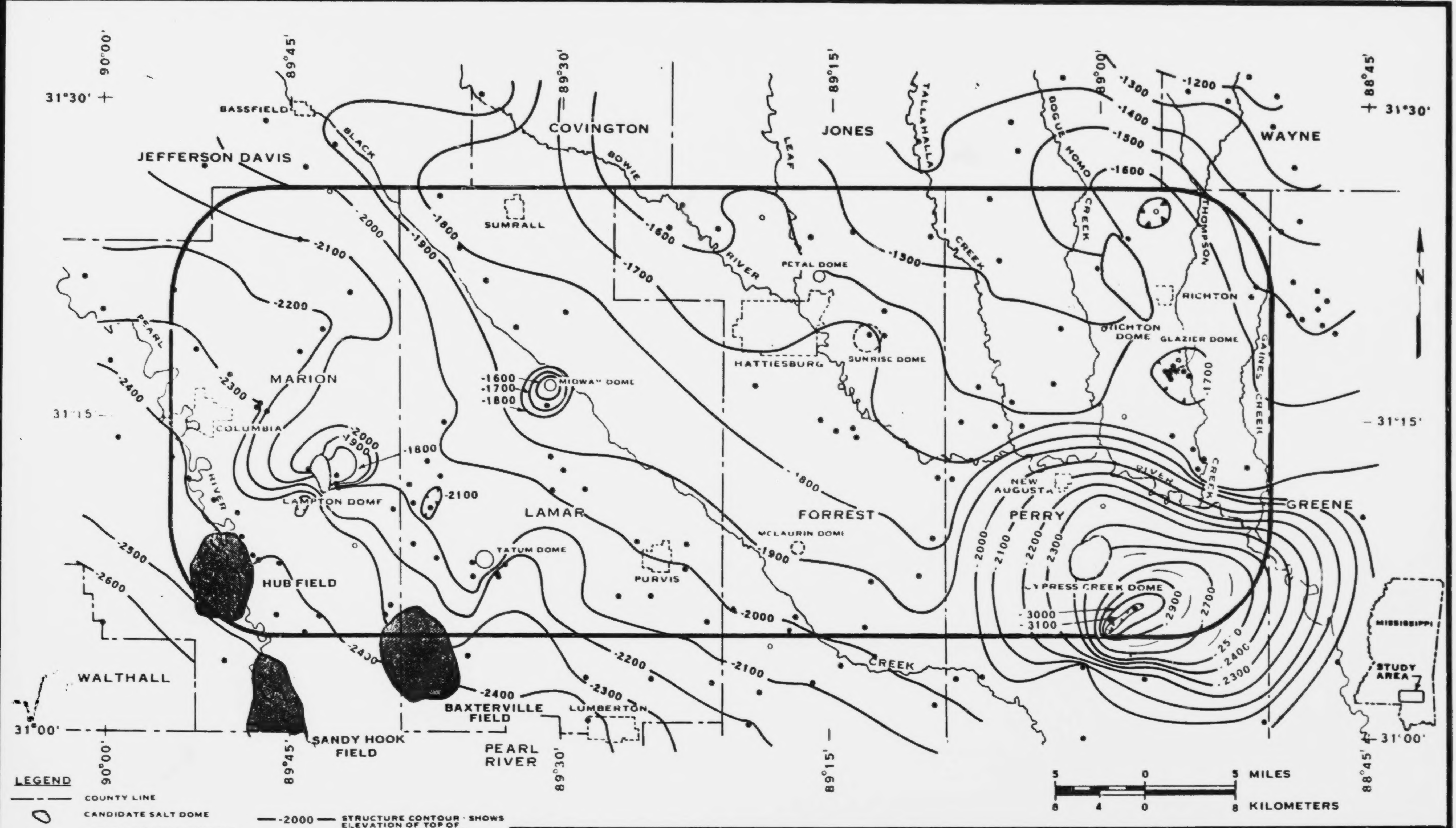
contain chalk or marl lentils in the lower half (Dinkins, 1967), is 7 to 19 meters (22 to 62 ft) thick in the study area. The Winona-Tallahatta contact is gradational to disconformable (Parks and others, 1963). The Zilpha Formation is 14 to 67 meters (45 to 220 ft) thick in the study area and is composed of interbedded clay shales, chalks, and chalky limestones (Dinkins, 1967). The Zilpha Formation conformably overlies the Winona Formation.

The Kosciusko (Sparta) Formation, which is locally sandy, consists of chalky or calcarenitic limestones, and clay shales (Dinkins, 1967) and is 37 to 113 (121 to 370 ft) thick in the study area. The Kosciusko (Sparta) Formation conformably overlies the Zilpha Formation. The structure of the top of the Kosciusko Formation is shown in Figure 12-17. The Cook Mountain Formation consists of porous carbonate sands, clay shales, and limestones (Dinkins, 1967) that are 34 to 79 meters (112 to 260 ft) thick in the study area. The structure and the thickness distribution of the Cook Mountain Formation are shown in Figures 12-18 and 12-22, respectively. The contact between the Cook Mountain and Kosciusko Formations generally is conformable (Mellen, 1959). The Cockfield Formation is represented by a sequence of limestones, sands, and lignite-bearing clays and silts which is 23 to 90 meters (76 to 295 ft) thick in the study area and which conformably overlies the Cook Mountain Formation (May, 1974).

12.2.2.3.2.2 Jackson Group: The Jackson Group consists of the Moodys Branch and Yazoo Formations, which are characterized as inner neritic to very shallow-marine deposits (Rainwater, 1963) without any known hydrocarbon resources (Mississippi State Oil and Gas Board, 1977). The Moodys Branch Formation is 3 to 11 meters (10 to 37 ft) thick in the study area and consists of a sequence of partially indurated, sometimes sandy marls, unconformably overlying the Cockfield Formation (May, 1974). The structure for the top of the Moodys Branch Formation is shown in Figure 12-19. The Yazoo Formation, which conformably overlies the Moodys Branch and is 34 to 101 meters (113 to 330 ft) thick in the study area, consists of variable limey, sandy, silty clays which grade vertically into limy units of the Ocala facies (Bicker, 1966). In some areas where the Yazoo Formation is exposed, it is used to produce a light-weight aggregate; however, there is no such production in the study area.

12.2.2.3.3 Oligocene Series - The Oligocene Series is represented within the study area by the Vicksburg Group and the Chickasawhay and Paynes Hammock Formations.

12.2.2.3.3.1 Vicksburg Group: The Vicksburg Group consists of the Forest Hill-Red Bluff undifferentiated unit, an undifferentiated Vicksburg limestone unit, and the Bucatunna Formation. This sequence generally is composed of shallow-marine and estuarine deposits which are economically important in outcrop areas for the production of portland cement, agricultural lime, rock wool, and bentonite (May, 1974; Bicker, 1970). However, these units are not exposed in the study area.


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
SUMRALL
HATTIESBURG
RICHTON
COLUMBIA
PURVIS
LUMBERTON
NEW AUGUSTA
PETAL DOME
SUNRISE DOME
RICHTON DOME
GLAZIER DOME
MIDWAY DOME
LAMPTON DOME
TATUM DOME
McLAURIN DOME
CYPRESS CREEK DOME
HUB FIELD
BAXTERVILLE FIELD
SANDY HOOK FIELD
BLACK
BOWIE
RIVER
LEAF
TALLAHALLA
CREEK
BOGUE HOMO
THOMPSON
GAINES CREEK
PEARL
HIVER
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
-2100
-2200
-2300
-2400
-2500
-2600
2700
2900
-3000
-3100
N
MISSISSIPPI
STUDY AREA
5 0 5 MILES
8 4 0 8 KILOMETERS
LEGEND
COUNTY LINE
CANDIDATE SALT DOME
NON CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
OIL & GAS FIELD
EXPLORATION WELL
AREA CHARACTERIZATION BORING
-2000 STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF KOSCIUSKO FORMATION. INTERVAL 100 FEET. DATUM IS MEAN SEA LEVEL.
-3100 CLOSED STRUCTURAL LOW

PREPARED JDG DATE 5-30-80
REVISED DATE 1-3-81
REVISED DATE
APPROVED DATE
T-1245-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

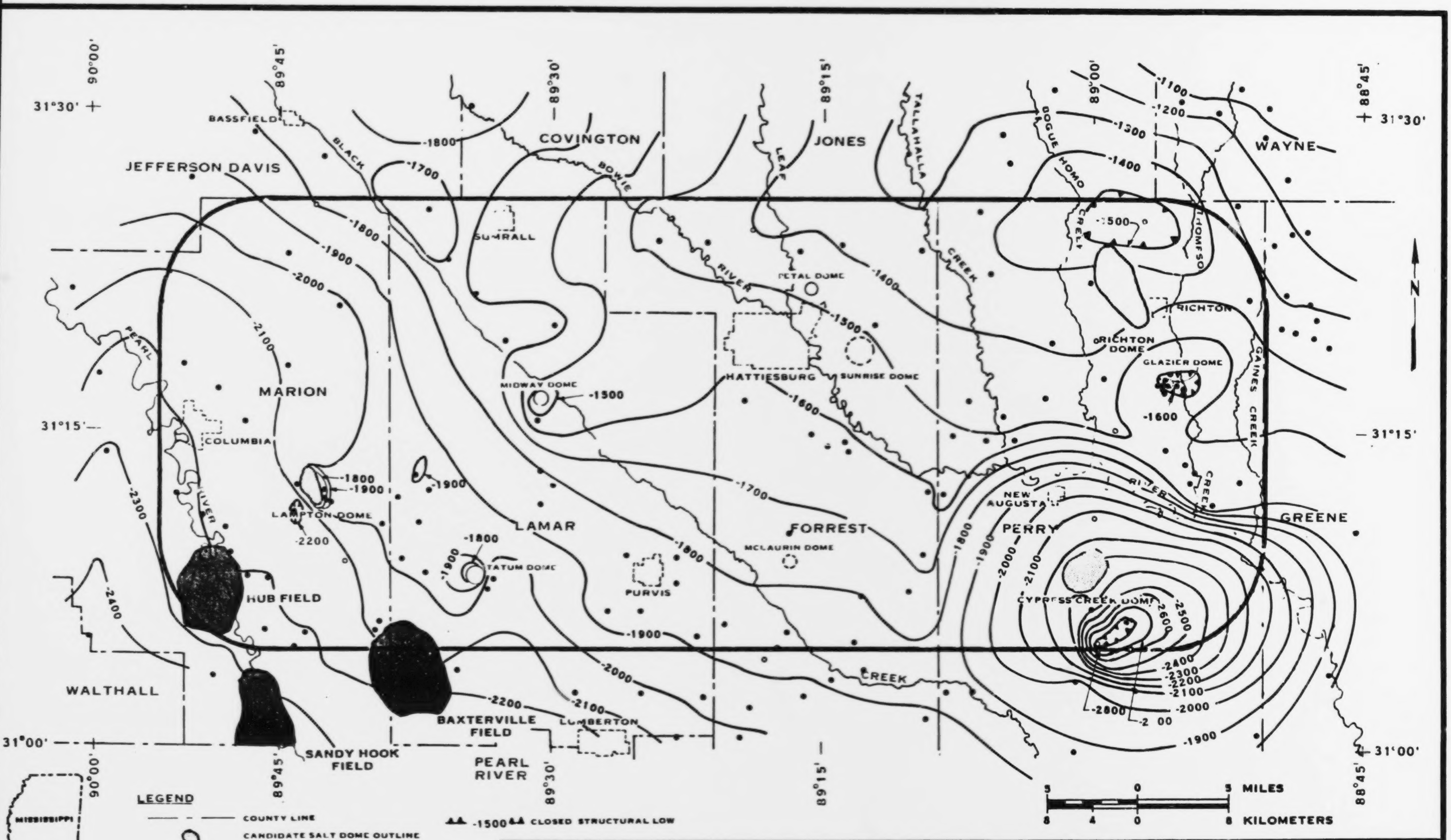
STRUCTURE CONTOUR MAP

TOP OF KOSCIUSKO (SPARTA) FORMATION

JOB NO. MV9600

FIGURE 12-17

BEST DOCUMENT AVAILABLE


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
N
BASSFIELD
BLACK
JEFFERSON DAVIS
COVINGTON
BOWIE
SUMRALL
JONES
LEAF
TALLAHALLA
CREEK
BOGUE HOMO
CREEK
THOMPSON
WAYNE
PETAL DOME
RIVER
RICHTON
RICHTON DOME
GLAZIER DOME
GAINES CREEK
PEARL
MARION
MIDWAY DOME
HATTIESBURG
SUNRISE DOME
COLUMBIA
LAMPTON DOME
RIVER
LAMAR
TATUM DOME
FORREST
MCLAURIN DOME
PURVIS
NEW AUGUSTA
PERRY
RIVER
CREEK
GREENE
CYPRESS CREEK DOME
HUB FIELD
WALTHALL
CREEK
BAXTERVILLE FIELD
LUMBERTON
SANDY HOOK FIELD
PEARL RIVER
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
-2100
-2200
-2300
-2400
-2500
-2600
-2800
5 0 5 MILES
8 4 0 8 KILOMETERS
MISSISSIPPI
STUDY AREA

LEGEND

— - —	COUNTY LINE
⬬	CANDIDATE SALT DOME OUTLINE
○	NON-CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
●	OIL & GAS FIELD
•	EXPLORATION WELL
∘	AREA CHARACTERIZATION BORING
—-2000—	STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF COOK MOUNTAIN FORMATION, INTERVAL 100 FEET DATUM IS MEAN SEA LEVEL
▲▲ -1500 ▲▲	CLOSED STRUCTURAL LOW

RREPARED J.C.G. DATE 5-30-80
REVISED DATE
REVISED DATE
APPROVED DATE [illegible]

T-1246-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

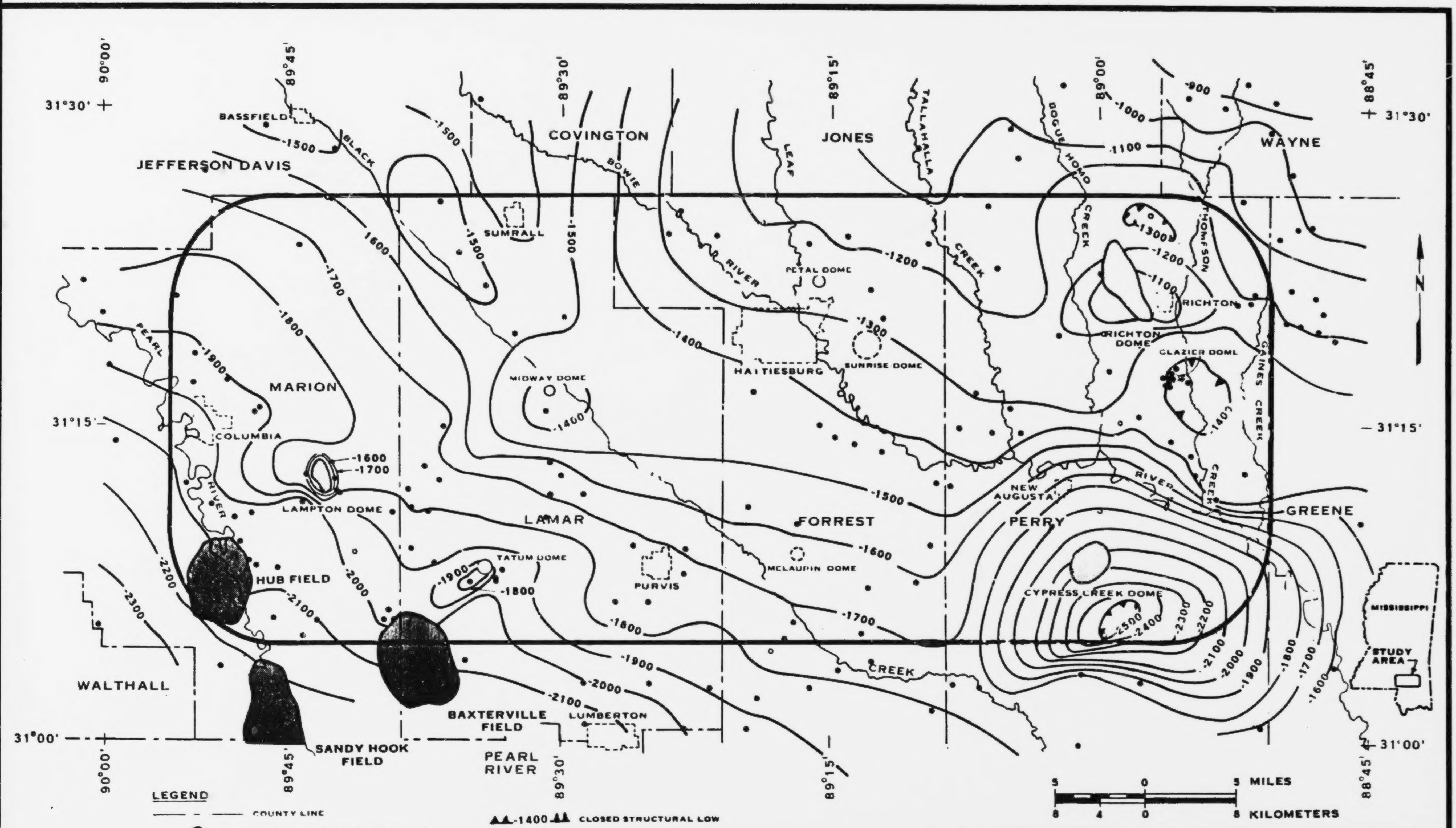
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

STRUCTURE CONTOUR MAP
TOP OF COOK MOUNTAIN FORMATION

JOB NO. MV9600 FIGURE 12-18

BEST DOCUMENT AVAILABLE


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
BASSFIELD
SUMRALL
COLUMBIA
HATTIESBURG
NEW AUGUSTA
RICHTON
PURVIS
LUMBERTON
PETAL DOME
SUNRISE DOME
MIDWAY DOME
LAMPTON DOME
TATUM DOME
MCLAURIN DOME
CYPRESS CREEK DOME
RICHTON DOME
GLAZIER DOME
HUB FIELD
BAXTERVILLE FIELD
SANDY HOOK FIELD
PEARL RIVER
BLACK
BOWIE
LEAF
TALLAHALLA
BOGUE HOMO
CREEK
THOMPSON
GAINES CREEK
RIVER
N
MISSISSIPPI
STUDY AREA
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
-2100
-2200
-2300
-2400
-2500
5 0 5 MILES
8 4 0 8 KILOMETERS
LEGEND
COUNTY LINE
▲▲-1400▲▲ CLOSED STRUCTURAL LOW
CANDIDATE SALT DOME OUTLINE
NON-CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
OIL & GAS FIELD
EXPLORATION WELL
AREA CHARACTERIZATION BORING
-1300 STRUCTURE CONTOUR SHOWS ELEVATION OF TOP OF MOODYS BRANCH FORMATION. INTERVAL 100 FEET DATUM IS MEAN SEA LEVEL.

PREPARED VDG. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1247-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

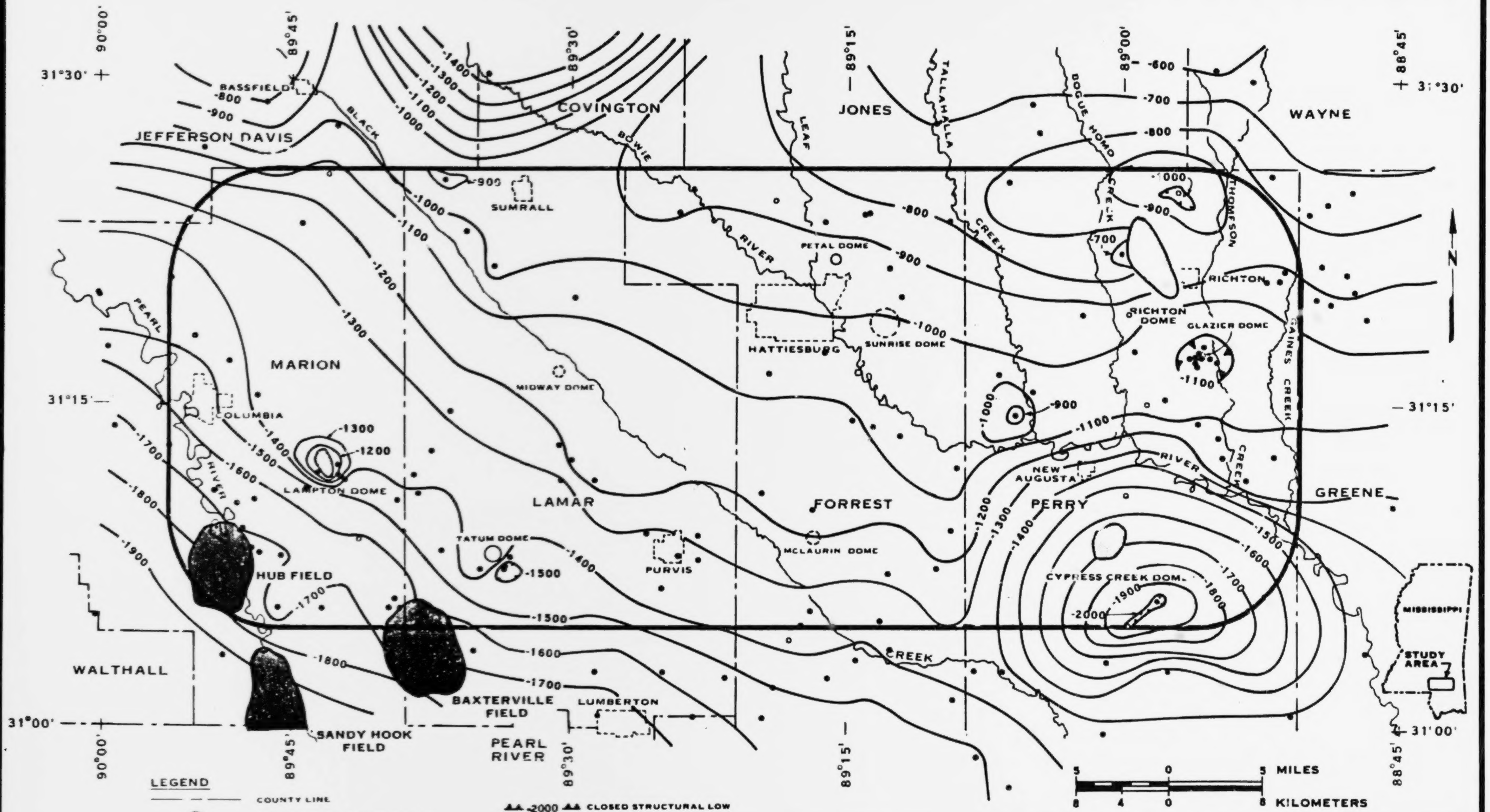
STRUCTURE CONTOUR MAP
TOP OF MOODYS BRANCH FORMATION

JOB NO. MV9600

FIGURE 12-19

52

BEST DOCUMENT AVAILABLE


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
SUMRALL
COLUMBIA
HATTIESBURG
PURVIS
LUMBERTON
RICHTON
NEW AUGUSTA
PETAL DOME
SUNRISE DOME
MIDWAY DOME
LAMPTON DOME
TATUM DOME
MCLAURIN DOME
RICHTON DOME
GLAZIER DOME
CYPRESS CREEK DOME
HUB FIELD
BAXTERVILLE FIELD
SANDY HOOK FIELD
PEARL RIVER
BLACK CREEK
BOWIE RIVER
LEAF RIVER
TALLAHALLA CREEK
BOGUE HOMO CREEK
THOMPSON CREEK
GAINES CREEK
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
N
MISSISSIPPI
STUDY AREA
5 0 5 MILES
8 4 0 8 KILOMETERS

LEGEND

— — —	COUNTY LINE
○	CANDIDATE SALT DOME OUTLINE
○	NON CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
●	OIL & GAS FIELD
•	EXPLORATION WELL
○	AREA CHARACTERIZATION BORING
—-1000—	STRUCTURE CONTOUR SHOWS ELEVATION OF TOP OF VICKSBURG LIMESTONES INTERVAL 100 FEET DATUM IS MEAN SEA LEVEL.
▲▲-2000▲▲	CLOSED STRUCTURAL LOW

PREPARED J.D.G. DATE 5-30-80
REVISED DATE
REVISED DATE
APPROVED DATE
T-1249-1

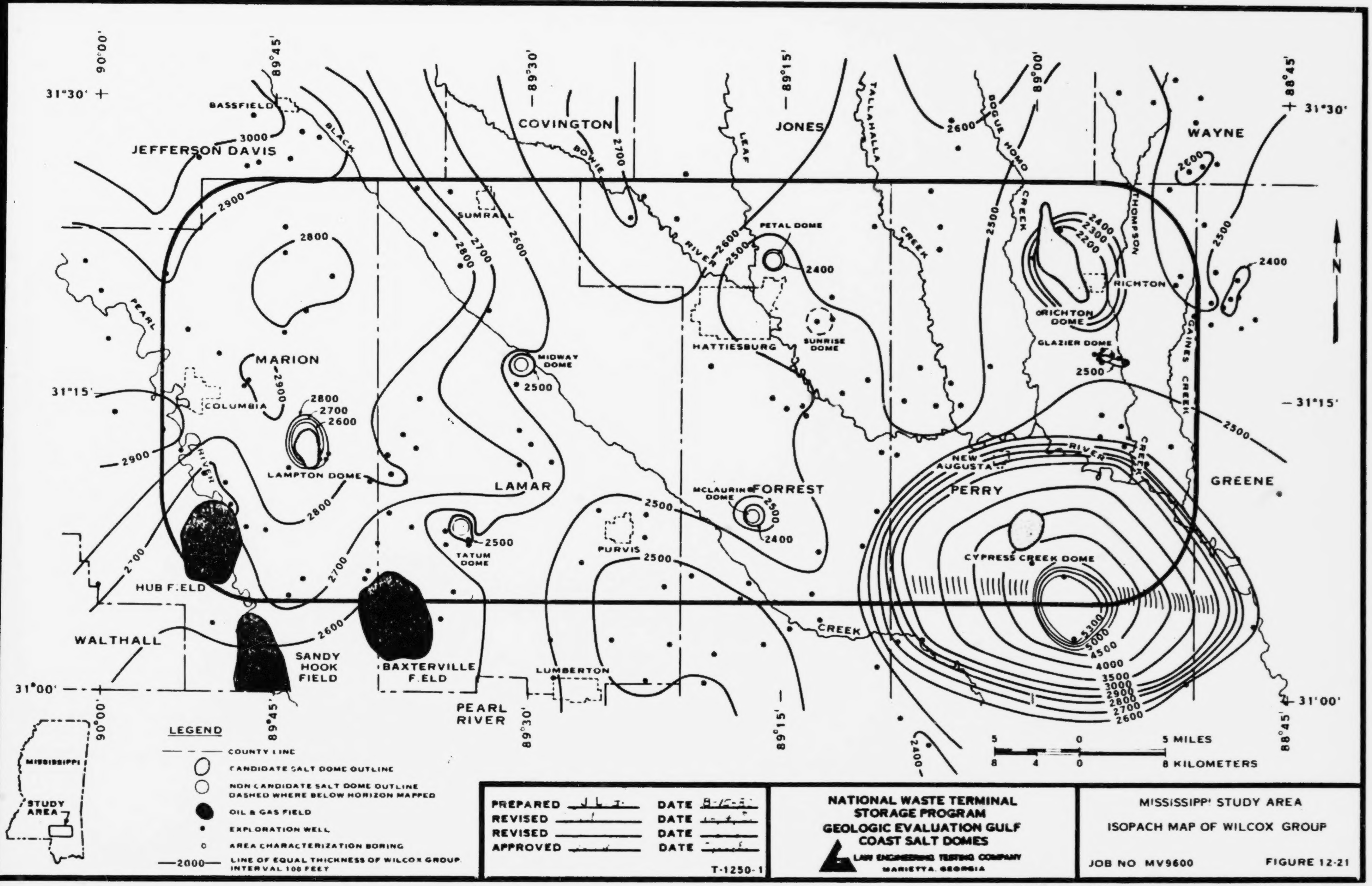
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

STRUCTURE CONTOUR MAP
TOP OF VICKSBURG LIMESTONES

JOB NO. MV9600 FIGURE 12-20

BEST DOCUMENT AVAILABLE


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
BASSFIELD
3000
JEFFERSON DAVIS
BLACK
COVINGTON
BOWIE
2700
LEAF
JONES
TALLAHALLA
2600
BOGUE HOMO
WAYNE
2600
SUMRALL
2900
2800
2800
2700
2600
RIVER
2600
2500
PETAL DOME
2400
CREEK
2500
CREEK
2400
2300
2200
THOMPSON
2500
2400
N
RICHTON
RICHTON DOME
GLAZIER DOME
2500
HATTIESBURG
SUNRISE DOME
PEARL
MARION
2900
MIDWAY DOME
2500
COLUMBIA
2800
2700
2600
GAINES CREEK
2500
2900
LAMPTON DOME
LAMAR
RIVER
NEW AUGUSTA
CREEK
PERRY
GREENE
HIRAM
2800
MCLAURIN DOME
FORREST
2500
2400
2500
2500
PURVIS
TATUM DOME
2500
CYPRESS CREEK DOME
2700
2700
HUB FIELD
2600
CREEK
WALTHALL
SANDY HOOK FIELD
BAXTERVILLE FIELD
LUMBERTON
5300
5000
4500
4000
3500
3000
2900
2800
2700
2600
PEARL RIVER
2400
5
0
5 MILES
8
4
0
8 KILOMETERS
MISSISSIPPI
STUDY AREA
LEGEND
COUNTY LINE
CANDIDATE SALT DOME OUTLINE
NON CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
OIL & GAS FIELD
EXPLORATION WELL
AREA CHARACTERIZATION BORING
—2000— LINE OF EQUAL THICKNESS OF WILCOX GROUP. INTERVAL 100 FEET

PREPARED		DATE	8-15-81
REVISED		DATE	
REVISED		DATE	
APPROVED		DATE	

T-1250-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

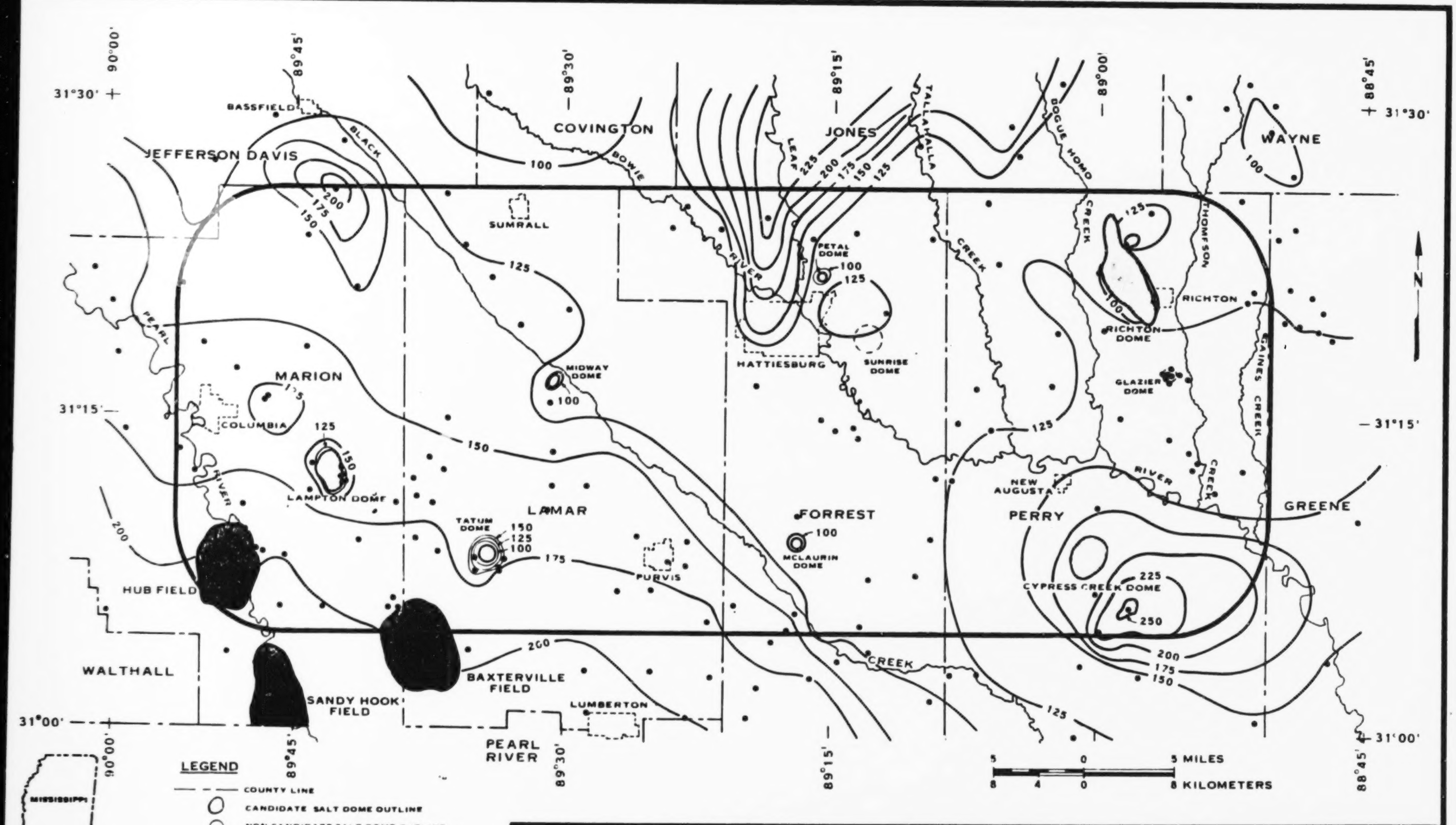
ISOPACH MAP OF WILCOX GROUP

JOB NO MV9600

FIGURE 12-21

54

BEST DOCUMENT AVAILABLE


31°30'
90°00'
89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
31°15'
31°00'
BASSFIELD
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
BLACK
BOWIE
LEAF
RIVER
TALLAHALLA
BOGUE HOMO
CREEK
THOMPSON
SUMRALL
PETAL DOME
RICHTON
RICHTON DOME
HATTIESBURG
SUNRISE DOME
GLAZIER DOME
PEARL
MARION
COLUMBIA
LAMPTON DOME
MIDWAY DOME
TATUM DOME
LAMAR
PURVIS
FORREST
MCLAURIN DOME
NEW AUGUSTA
PERRY
GREENE
GAINES CREEK
CYPRESS CREEK DOME
HUB FIELD
WALTHALL
SANDY HOOK FIELD
BAXTERVILLE FIELD
LUMBERTON
PEARL RIVER
N
100
125
150
175
200
225
250
5 0 5 MILES
8 4 0 8 KILOMETERS
MISSISSIPPI
STUDY AREA

LEGEND

- COUNTY LINE
- CANDIDATE SALT DOME OUTLINE
- NON-CANDIDATE SALT DOME OUTLINE DASHED WHERE BELOW HORIZON MAPPED
- OIL & GAS FIELD
- EXPLORATION WELL
- AREA CHARACTERIZATION BORING
- —125— LINE OF EQUAL THICKNESS OF COOK MOUNTAIN FORMATION INTERVAL 25 FEET

PREPARED ______ DATE ______
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE ______
T-1252-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
ISOPACH MAP OF COOK MOUNTAIN FORMATION
JOB NO MV9600
FIGURE 12-22

BEST DOCUMENT AVAILABLE

The Forest Hill-Red Bluff unit consists of carbonaceous clays and partially indurated marls, 5 to 30 meters (15 to 98 ft) thick in the study area, unconformably overlying the Yazoo Formation. The Vicksburg limestone unit consists of interbedded limestones, bentonites, clay shales, and clays (Dinkins, 1967) which are 19 to 66 meters (61 to 218 ft) thick in the study area, unconformably overlying the Forest Hill-Red Bluff unit (May, 1974). The structure on the top of the Vicksburg limestone unit is shown in Figure 12-20 The Bucatunna Formation conformably overlies the Vicksburg limestone unit, is 3 to 28 meters (11 to 91 ft) thick in the study area, and includes sandstones, sandy marls, and calcareous clays (Dinkins, 1967).

The Chickasawhay Formation is 14 to 66 meters (46 to 215 ft) thick and regionally consists of limestones interbedded with clays and marls (May, 1974) which conformably overlie the Bucatunna Formation (Mellen, 1959). Regionally, the Paynes Hammock Formation consists of 1.5 to 7 meters (5 to 23 ft) (May, 1974) of marls interbedded with sandstones, clays, and silty limestones, unconformably overlying the Chickasawhay Formation (May, 1974).

12.2.2.3.4 Miocene and Plio-Miocene Series - The Miocene and Plio-Miocene Series are represented by two formations not assigned to a particular group. These units, consisting of shallow-marine and fluviatile deposits (May, 1974), include the Catahoula and the undifferentiated Pascagoula-Hattiesburg Formations. The Catahoula is composed of up to 305 meters (1,000 ft)

(Childress, 1973) of silts, clays, sands, gravels, and lignites which are conformable with the underlying Paynes Hammock Formation. The Catahoula Formation consists of a basal limestone member, the Tatum Limestone, which is usually characterized by foraminiferal beds known as the *Heterostegina* zone. The Catahoula Formation contains lignite interbeds, whereas the Pascagoula-Hattiesburg unit contains sands and gravels used in construction, clays used in brickmaking, and minor interbedded lignites (Logan, 1908; Mississippi State Oil and Gas Board, 1977).

Regionally, the Pascagoula-Hattiesburg unit consists of 107 to 701 meters (350 to 2,300 ft) of interbedded gravelly sands, silty clays, lignites, and sands (Eargle, 1968) and unconformably overlies the Catahoula Formation (May, 1974). Generally, the Pascagoula Formation is differentiated from the underlying Hattiesburg Formation on the basis of brackish-water fossils found in the Pascagoula Formation (Williams, 1967). No such fossils were observed during the Area Characterization field program in the Mississippi Study Area. Accordingly, the Pascagoula Formation is probably absent in most portions of the study area, although Foster and McCutcheon (1941) reported its presence in northernmost Forrest County. The Catahoula and Hattiesburg Formations have a combined thickness of 259 to 607 meters (849 to 1,991 ft) in the study area.

12.2.2.4 Quaternary System: The age relationships and origin of the Quaternary units, which are dominantly fluviatile deposits, have been and continue to be the subject of much debate. In southern Mississippi, the Quaternary System includes the Plio-Pleistocene Citronelle Formation, Pleistocene terrace deposits, and Recent alluvium. The Citronelle, which according to Eargle (1968) is fluviatile to littoral, deltaic, lagoonal, or estuarine, is up to 66 meters (215 ft) thick in the study area and consists of silty, clayey sands and gravels. The Citronelle Formation unconformably overlies the Pascagoula-Hattiesburg unit (Bicker, 1970; Eargle, 1968) and is also unconformable with the younger terrace deposits (Williams, 1967).

The Pleistocene terrace deposits are composed of the products of erosion and reworking of the Citronelle Formation and older formations. A lowering of the base level, resulting from sea level changes subsequent to deposition of the Citronelle Formation, caused streams to cut valleys into the Citronelle surface, reworking and depositing clays, sands, and gravels on the flood plains downstream from their source area. These flood plains were subsequently incised, forming terraces. The eroded floodplain material was deposited downstream. The terrace deposits are absent in many places but may be as thick as 15 meters (50 ft). They consist of fine to coarse-grain quartz sands with some gravel and clay lenses (May, 1974). The terrace deposits, as well as the Recent alluvium, are excavated extensively for construction aggregates.

Recent alluvial deposits are generally topographically lower than the terrace deposits and commonly overlie pre-Citronelle strata because of the deep erosion of the Citronelle and terraces by regional streams (Williams, 1967). The alluvial deposits range up to 38 meters (125 ft) in thickness (Shows and others, 1966) and consist of quartz sands, cherty and quartzose gravels, and silty clays (May, 1974).

12.2.3 STRUCTURE: The Mississippi Study Area, located entirely within the southeastern portion of the Mississippi Salt Basin, contains structural elements characteristic of the salt basin. The basin lies within the southeastern portion of a large gulfward-plunging syncline referred to as the Mississippi Embayment (Figure 12-5). This large, regional feature, which forms a broad embayment reflected in the disposition of middle to late Mesozoic and Tertiary rocks, is a portion of the Gulf of Mexico Basin. As a structural salient, the embayment extends northward to the approximate junction of the Ohio and Mississippi Rivers in southern Illinois, and from East Texas to western Alabama.

The Mississippi Salt Basin is a deep asymmetric depression, 402 km (250 mi) long and 97 km (60 mi) wide which extends from the Monroe Platform in northeastern Louisiana across the axis of the Mississippi Embayment to the Jackson-Mobile Graben in southwestern Alabama (Figure 12-5). In eastern Mississippi, the basin is bounded on the north by the Pickens-Gilbertown Fault Zone, and on the south by the Hancock County High, a portion of the Wiggins Uplift. The salt basin occupies approximately 38,850 km^2 (15,000 mi^2) of the Mississippi Embayment (Anderson and others, 1973).

Within the basin, Jurassic and younger sediments overlie the Paleozoic to early Mesozoic basement. The salt basin is characterized by a steepening of dips and increased thicknesses of Mesozoic and early Cenozoic strata towards the center. The top of the Louann Salt is approximately 3,658 meters (12,000 ft) deep beneath the northern flank of the basin, and at least 8,230 meters (27,000 ft) deep beneath the axis of the basin (Anderson and others, 1973). The salt is inferred to be approximately 1,829 meters (6,000 ft) thick beneath the axis in eastern Mississippi (Anderson and others, 1973). Seismic refraction data through the basin indicate that an asymmetric depression exists, not only within the sedimentary section, but also in the basement structure (Warren and others, 1966). However, there is comparatively little structural expression of the basin in Tertiary and younger strata (Anderson and others, 1973).

Located within the Mississippi Basin are two major structural features, the Wiggins Anticline and the Perry Basin (also called the East Mississippi Syncline). Most of the Perry Basin lies within the study area, whereas the Wiggins anticlinal axis is south, outside the study area's southern boundary (Figures 12-5 and 12-12). The Perry Basin is apparently a large salt withdrawal basin. However, deep faulting beneath the Perry Basin may also exert some control over the formation of the basin. On the other hand, the Wiggins Anticline may be the result of crustal subsidence and flexure caused by sediment loading. The Perry Basin and the Wiggins Anticline are discussed in Sections 12.2.3.2 and 12.2.3.3, respectively.

Most of the remaining structural elements within the salt basin and study area appear to be related to salt movement. Approximately 77 known or suspected salt domes exist in the Mississippi Salt Basin (Anderson and others, 1973). Nine of these domes lie within the study area (Figure 12-12). Each dome is typically associated with local normal faults, anticlines, and synclines formed by the movement of diapiric salt structures or nonpiercement salt swells. Low-relief, deep-seated salt ridges have been identified in the study area and throughout the entire salt basin (Frascogna, 1957).

Published precise leveling data (Holdahl and Morrison, 1974) indicate uplift of the modern surface in the range of 2 to 4 mm/yr (0.07 to 0.15 in/yr) along a traverse partly across the study area and elsewhere in southeastern Mississippi. This reported trend is based on adjustments of first- and second-order leveling data as old as 1897, combined with modern data gathered up to about 1970. Cornell University is currently reviewing the data used by Holdahl and Morrison to evaluate the effect of changes in the types of instrumentation and leveling procedures in the span of years over which the data were acquired. The results of the current study, together with topographic evidence, may have an important bearing on confirmation of the tectonic stability of the region.

12.2.3.1 Structural Trends: Figures 12-13 through 12-20 are structure contour maps for the tops of the following stratigraphic units: Lower Tuscaloosa, Selma, Porters Creek, Wilcox, Kosciusko (Sparta), Cook Mountain, Moodys Branch, and Vicksburg. These maps were prepared from analyses of well data developed from borings drilled for this study, and from existing petroleum and mineral exploration wells. The interesting structures of Hub and Baxterville Fields, suspected of being underlain by salt bodies, are presented in detailed published maps shown in Figures 12-23 and 12-24, and are discussed in Section 12.2.3.4.

The structure contour maps of the study area reflect decreasing structural relief and complexity on progressively younger sedimentary horizons, as, for example, the Perry Basin, discussed in Section 12.2.3.2, (Figures 12-13 through 12-20). The number of faults recognized also decreases up through the stratigraphic section.

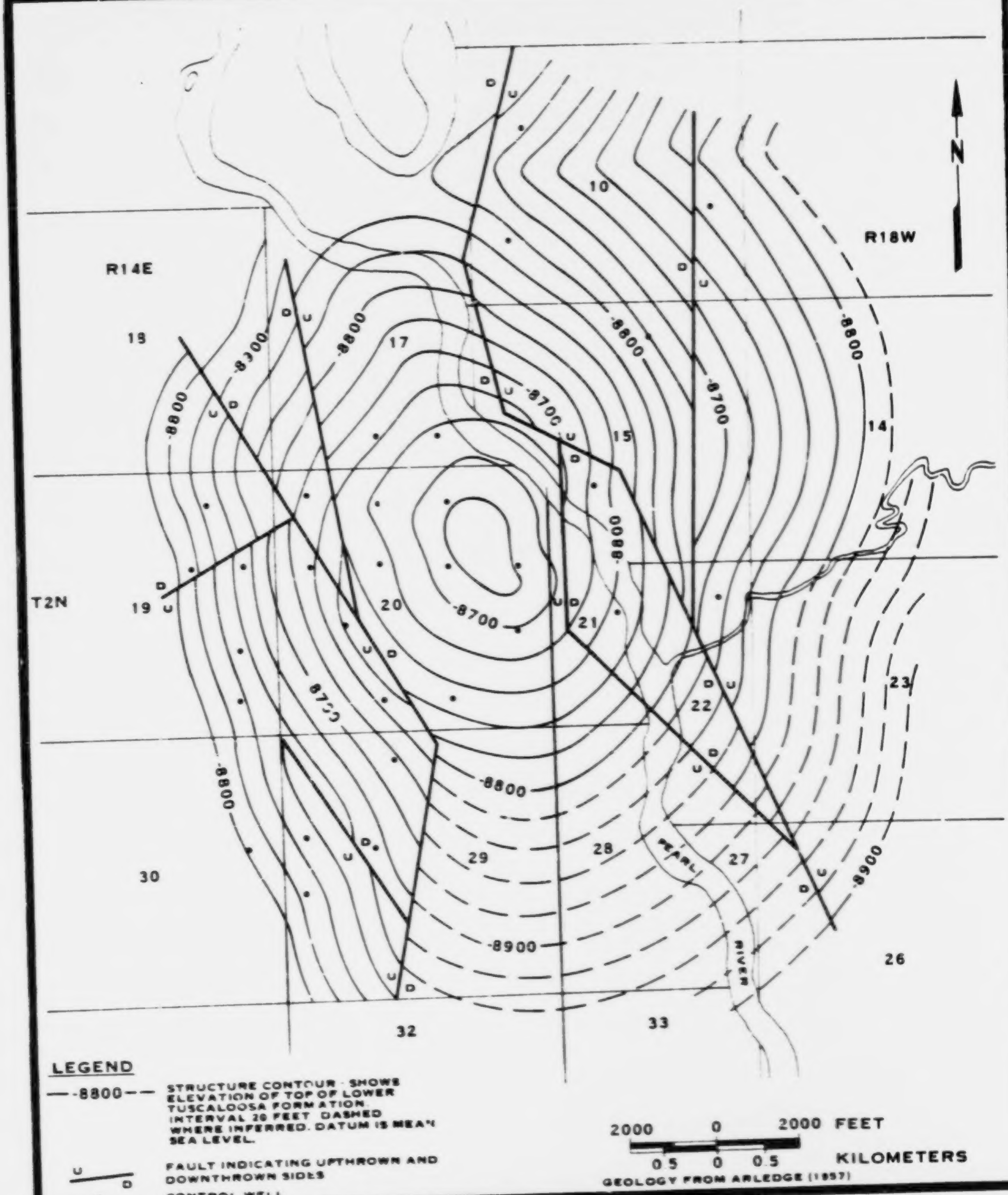
The general strike of the units mapped shifts progressively westward from a northerly trend on the older horizons to westerly on the younger horizons (Figures 12-13 through 12-20). The strata generally exhibit a more westerly strike in the northeastern portion of the study area than in the western half. The strike of the strata in the southeastern portion of the study area is controlled by subsidence of beds in the Perry Basin. The regional dip is westerly on the older horizons and on the younger horizons.

Figure 12-13 illustrates the structure on top of the Lower Tuscaloosa Formation. The strike of this unit in the western portion of the map is generally northerly, but northwest of Lampton dome it changes to a northeasterly direction. The dip in this area is approximately 12 m/km (62 ft/mi) to the west and northwest. Strike in the extreme northeastern portion of the study area is generally north-northwesterly, and dips are about 42 to 57 m/km (220 to 300 ft/mi) to the southwest. The southeastern corner of the study area is dominated by the elliptical Perry Basin, where the dips of the Lower Tuscaloosa range from approximately 62 to 106 m/km (330 to 560 ft/mi) toward the center of the basin.

The nine piercement salt domes in the study area are quite prominent in the structure contoured on the top of the Lower Tuscaloosa. Lampton, Tatum, Midway, McLaurin, Petal, Sunrise, and Glazier Domes are all closed structural highs, whereas the beds in the vicinity of Richton Dome exhibit only partial closure against the salt column. The influence of positive structure over Cypress Creek Dome on the top of Lower Tuscaloosa has been obscured by the magnitude of subsidence in the Perry Basin. The westernmost salt domes appear as closed structural highs superimposed upon several northerly to northwesterly trending anticlines and synclines (Figure 12-13). Lampton and Tatum Domes are on separate limbs of a northerly trending anticline. Tatum Dome is at the extreme southern end of a northerly trending syncline. To the east of this syncline Midway Salt Dome is located on a northerly to northwesterly trending anticlinal structure. Another northwesterly trending anticlinal structure is mapped farther east between Midway and Petal Domes.

These deep, alternating anticlinal and synclinal structures may reflect the existence of linear salt ridges and salt-withdrawal troughs with several of the salt domes occuring along

AF 12338A


N
R14E
R18W
T2N
10
14
15
17
18
19
20
21
22
23
26
27
28
29
30
32
33
-8800
-8700
-8900
D
U
PEARL RIVER
2000 0 2000 FEET
0.5 0 0.5 KILOMETERS

LEGEND

—-8800—— STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF LOWER TUSCALOOSA FORMATION. INTERVAL 20 FEET. DASHED WHERE INFERRED. DATUM IS MEAN SEA LEVEL.

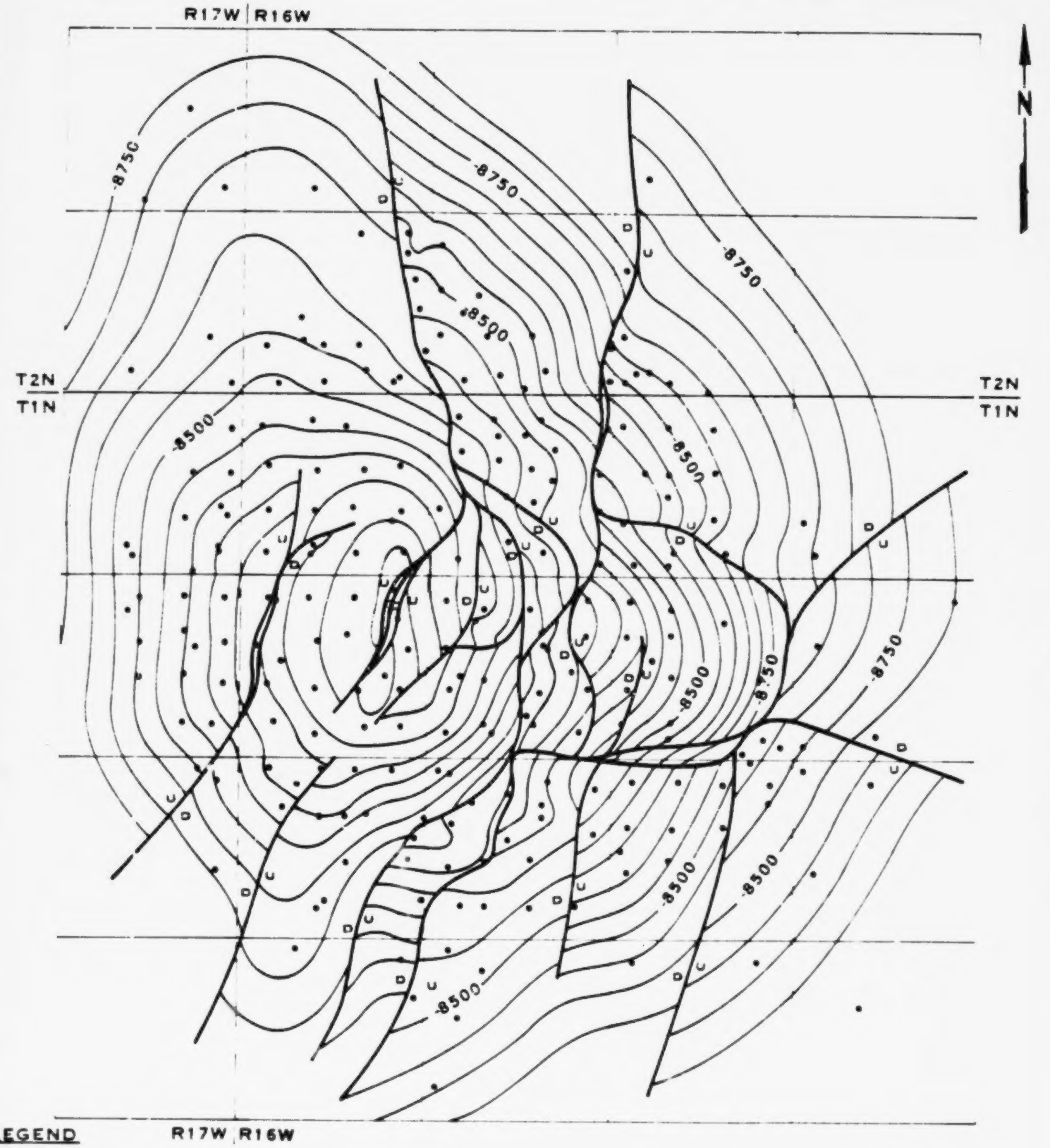
U/D FAULT INDICATING UPTHROWN AND DOWNTHROWN SIDES

● CONTROL WELL

GEOLOGY FROM ARLEDGE (1957)

PREPARED ____ DATE ____ REVISED ____ DATE ____ REVISED ____ DATE ____ APPROVED ____ DATE ____ T-1254-1	NATIONAL WASTE TERMINAL STORAGE PROGRAM GEOLOGIC EVALUATION GULF COAST SALT DOMES LAW ENGINEERING TESTING COMPANY MARIETTA GEORGIA	MISSISSIPPI STUDY AREA HUB FIELD STRUCTURE MAP - TOP OF LOWER TUSCALOOSA FORMATION JOB NO. MV9600 FIGURE 12-23

BEST DOCUMENT AVAILABLE


R17W | R16W
N
-8750
-8750
-8750
-8500
T2N
T1N
T2N
T1N
-8500
-8500
-8500
-8750
-8750
-8500
-8500
-8500
-8500
U
D
R17W | R16W

LEGEND

—-8500— STRUCTURE CONTOUR · SHOWS ELEVATION OF TOP OF DAVIS SAND MEMBER. INTERVAL 50 FEET. DATUM IS MEAN SEA LEVEL. DASHED WHERE INFERRED.

U/D FAULT INDICATING UPTHROWN AND DOWNTHROWN SIDES

• CONTROL WELL

0.5 0 0.5 MILES

0.5 0 0.5 KILOMETERS

GEOLOGY FROM DAVIS & LAMBERT (1963)

PREPARED [illegible] DATE 9-15-[illegible]
REVISED [illegible] DATE [illegible]
REVISED ____ DATE ____
APPROVED [illegible] DATE [illegible]
T-1255-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
BAXTERVILLE FIELD
STRUCTURE MAP-TOP OF DAVIS SAND MEMBER,
LOWER TUSCALOOSA FORMATION
JOB NO. 1V9600 FIGURE 12-24

65 BEST DOCUMENT AVAILABLE

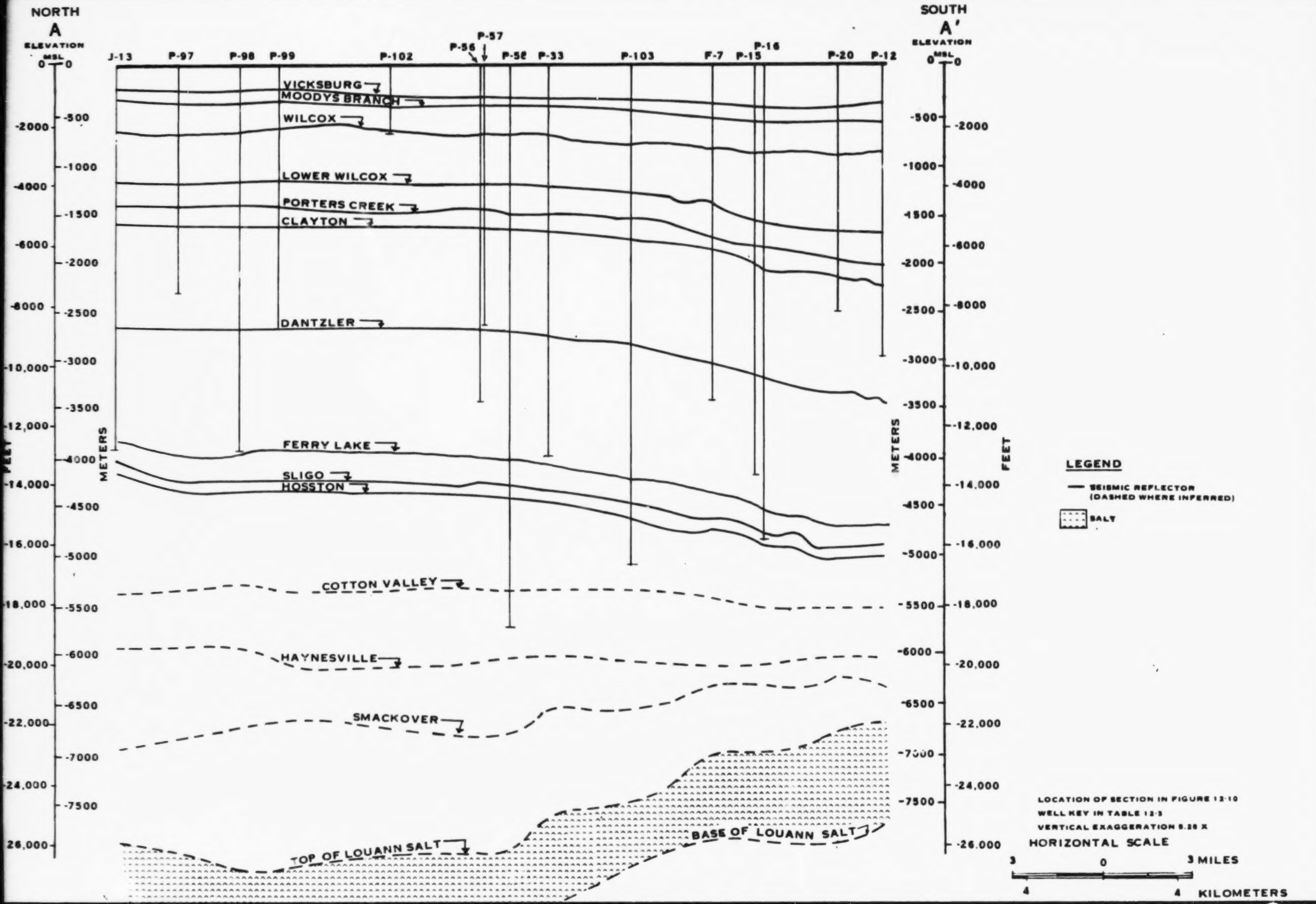
the ridges. Where mapped, strata younger than the Lower Tuscaloosa do not reflect the linear structural troughs and ridges, presumably indicating a decrease in the growth of salt ridges subsequent to Lower Tuscaloosa deposition.

Six common-depth-point (CDP) seismic reflection lines were purchased for this study and interpreted by Law Engineering personnel (Figures 12-25 through 12-30 and Table 12-3). The locations of these lines are shown on Figure 12-10. These lines are all located within the eastern half of the study area. Reflecting horizons were picked down to the base of the Louann Salt; however, reflectors below the Hosston are inferred and the interpretation does not seem to reflect known structural trends. Regional dips outside the Perry Basin generally decrease from greater than 19 m/km (100 ft/mi) on the Hosston reflector (seismic section A-A', Figure 12-25) to nearly horizontal on the younger horizons (Seismic Section E-E', Figure 12-29).

12.2.3.2 Perry Basin: The Perry Basin (or East Mississippi Syncline) was a center of deposition throughout late Tertiary time. This elliptical basin forms a persistent negative area north of the Wiggins Anticline in Perry County, Mississippi (Murray, 1961). Figures 12-13 through 12-20 and 12-12 show that the Perry Basin generally trends west-northwesterly to westerly, and extends eastward for approximately 39 km (24 mi) from Forrest County across south-central Perry County into Greene County. The basin is characterized by thick accumulations of sediments and a progressive steepening of dips into the basin (Nunnally and Fowler, 1954).

Figures 12-13 through 12-20 illustrate structural closure of the Perry Basin on various horizons from the top of the Lower Tuscaloosa Formation to the top of the Vicksburg Formation. The changing configuration of the basin as demonstrated by these structure maps is primarily a function of the density of well control which varies from one horizon to the next, though the gradual shallowing trend upward through the section is distinctly developed. The structure contours on the top of the Lower Tuscaloosa (Figure 12-13) show the basin extending into easternmost Forrest County with more than 914 meters (3,000 ft) of relief in the Basin. This compares with approximately the same amount of relief on the tops of the Selma and Porters Creek, and only 457 meters (1,500 ft) on the Wilcox (Figures 12-14 through 12-16). Above the Wilcox, relief in the basin progressively decreases to approximately 335, 274, and 152 meters (1,100, 900, and 500 ft) on the tops of the Kosciusko, Cook Mountain, Moodys Branch, and Vicksburg Formations, respectively (Figures 12-17 through 12-20).

Two seismic reflection lines purchased for this study cross the approximate center of the Perry Basin. Seismic Section C-C' (Figure 12-27) shows that the strata in the basin are downwarped with decreasing structural relief on progressively younger sediments. This structural relief on seismic reflectors corresponding to the Dantzler, Clayton, Porters Creek, Lower Wilcox, Wilcox, Moodys Branch, and Vicksburg is measured at 1,219, 1,097, 975, 853, 488, 244, and 213 meters (4,000, 3,600, 3,200, 2,800, 1,600, 800, and 700 ft), respectively. A large normal fault displaces strata from the base of the Louann Salt to about the


NORTH
A
ELEVATION
MSL
SOUTH
A'
ELEVATION
MSL
J-13
P-97
P-98
P-99
P-102
P-56
P-57
P-58
P-33
P-103
F-7
P-15
P-16
P-20
P-12
VICKSBURG
MOODYS BRANCH
WILCOX
LOWER WILCOX
PORTERS CREEK
CLAYTON
DANTZLER
FERRY LAKE
SLIGO
HOSSTON
COTTON VALLEY
HAYNESVILLE
SMACKOVER
TOP OF LOUANN SALT
BASE OF LOUANN SALT
0
-2000
-4000
-6000
-8000
-10,000
-12,000
-14,000
-16,000
-18,000
-20,000
-22,000
-24,000
-26,000
FEET
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
-5000
-5500
-6000
-6500
-7000
-7500
METERS
LEGEND
SEISMIC REFLECTOR (DASHED WHERE INFERRED)
SALT
LOCATION OF SECTION IN FIGURE 12-10
WELL KEY IN TABLE 12-3
VERTICAL EXAGGERATION 5.28 X
HORIZONTAL SCALE
3
0
3 MILES
4
4 KILOMETERS

MISSISSIPPI STUDY AREA

SEISMIC SECTION A-A'

JOB NO. MV9600

FIGURE 12-25

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

PREPARED ____ DATE 8-15-80
REVISED ____ DATE
REVISED ____ DATE
APPROVED ____ DATE

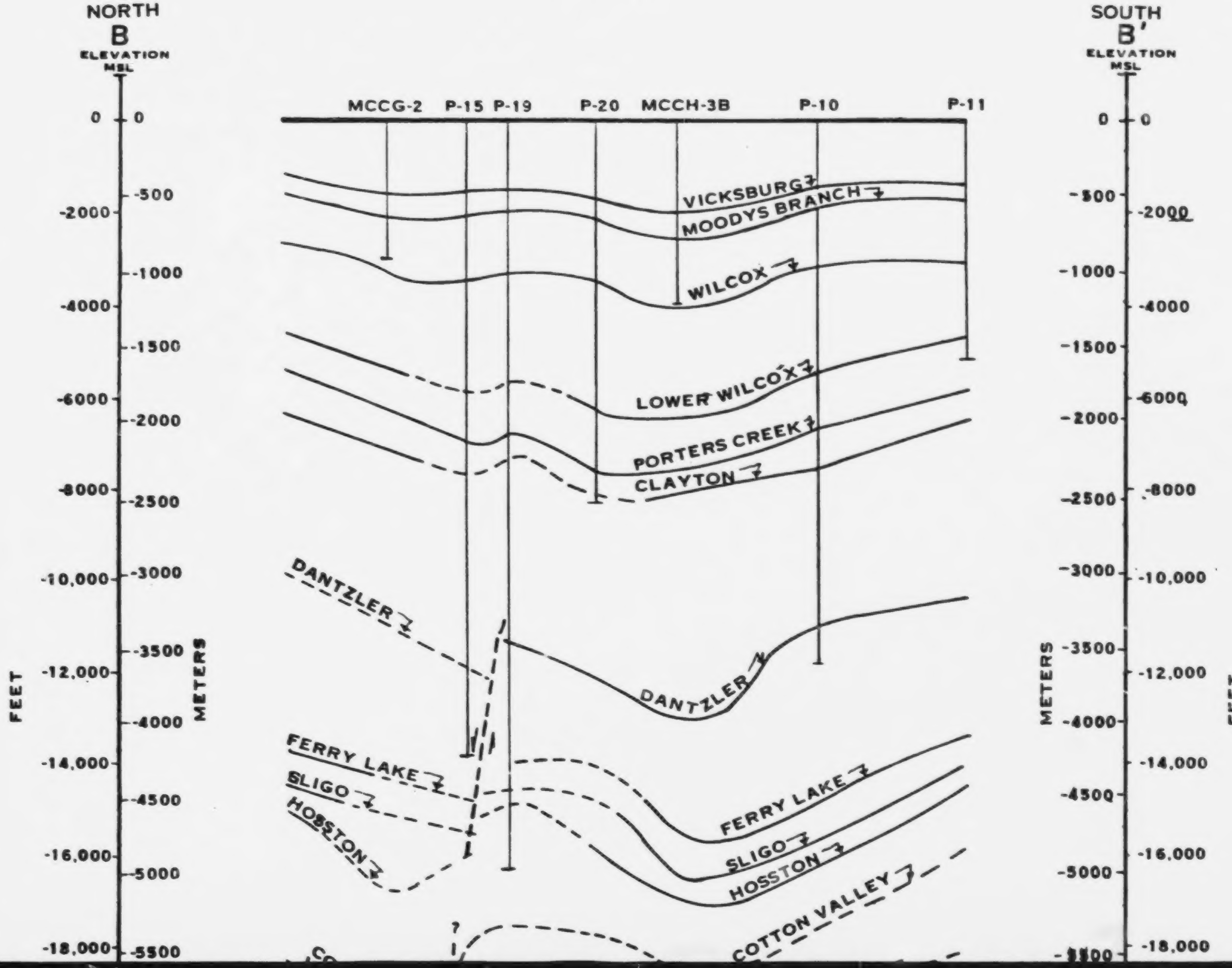
T-1437-1

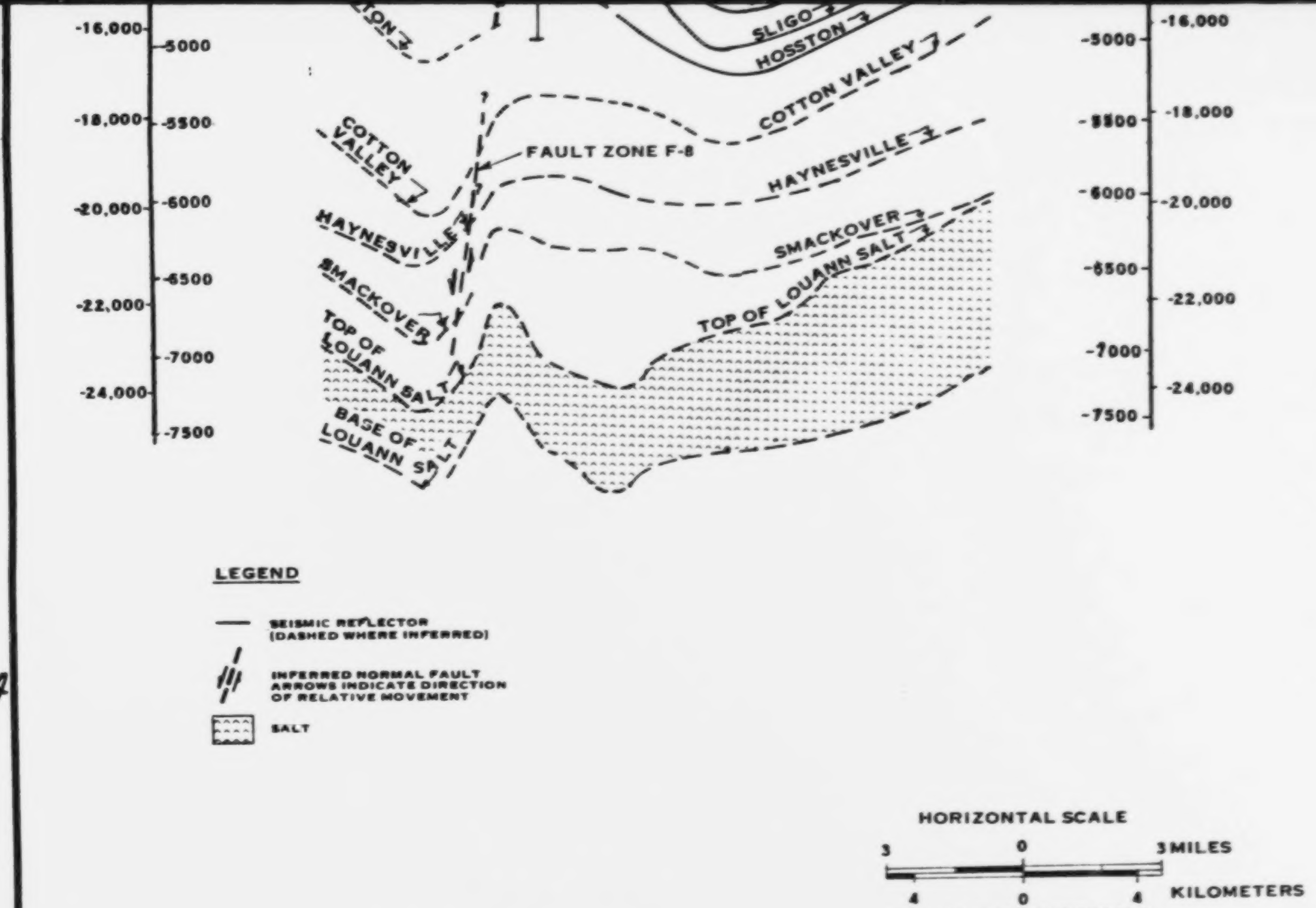
FIGURE 12-25

BEST DOCUMENT AVAILABLE

68

BEST DOCUMENT AVAILABLE


NORTH
B
ELEVATION MSL
SOUTH
B'
ELEVATION MSL
MCCG-2
P-15
P-19
P-20
MCCH-3B
P-10
P-11
VICKSBURG
MOODYS BRANCH
WILCOX
LOWER WILCOX
PORTERS CREEK
CLAYTON
DANTZLER
DANTZLER
FERRY LAKE
SLIGO
HOSSTON
FERRY LAKE
SLIGO
HOSSTON
COTTON VALLEY
?
FEET
METERS
METERS
FEET
0
-2000
-4000
-6000
-8000
-10,000
-12,000
-14,000
-16,000
-18,000
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
-5000
-5500


-16,000
-5000
-18,000
-5500
-20,000
-6000
-22,000
-6500
-7000
-24,000
-7500
-16,000
-5000
-18,000
-5500
-20,000
-6000
-6500
-22,000
-7000
-24,000
-7500
SLIGO
HOSSTON
COTTON VALLEY
FAULT ZONE F-8
HAYNESVILLE
SMACKOVER
TOP OF LOUANN SALT
BASE OF LOUANN SALT
LEGEND
SEISMIC REFLECTOR (DASHED WHERE INFERRED)
INFERRED NORMAL FAULT ARROWS INDICATE DIRECTION OF RELATIVE MOVEMENT
SALT
HORIZONTAL SCALE
3
0
3 MILES
4
0
4
KILOMETERS

VERTICAL EXAGGERATION 5.28 X
LOCATION OF SECTION IN FIGURE 12-18
WELL KEY IN TABLE 12-3

69A

FIGURE 12-26

PREPARED J.E.G DATE 8-15-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED DATE 8/20/80

T-1438-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

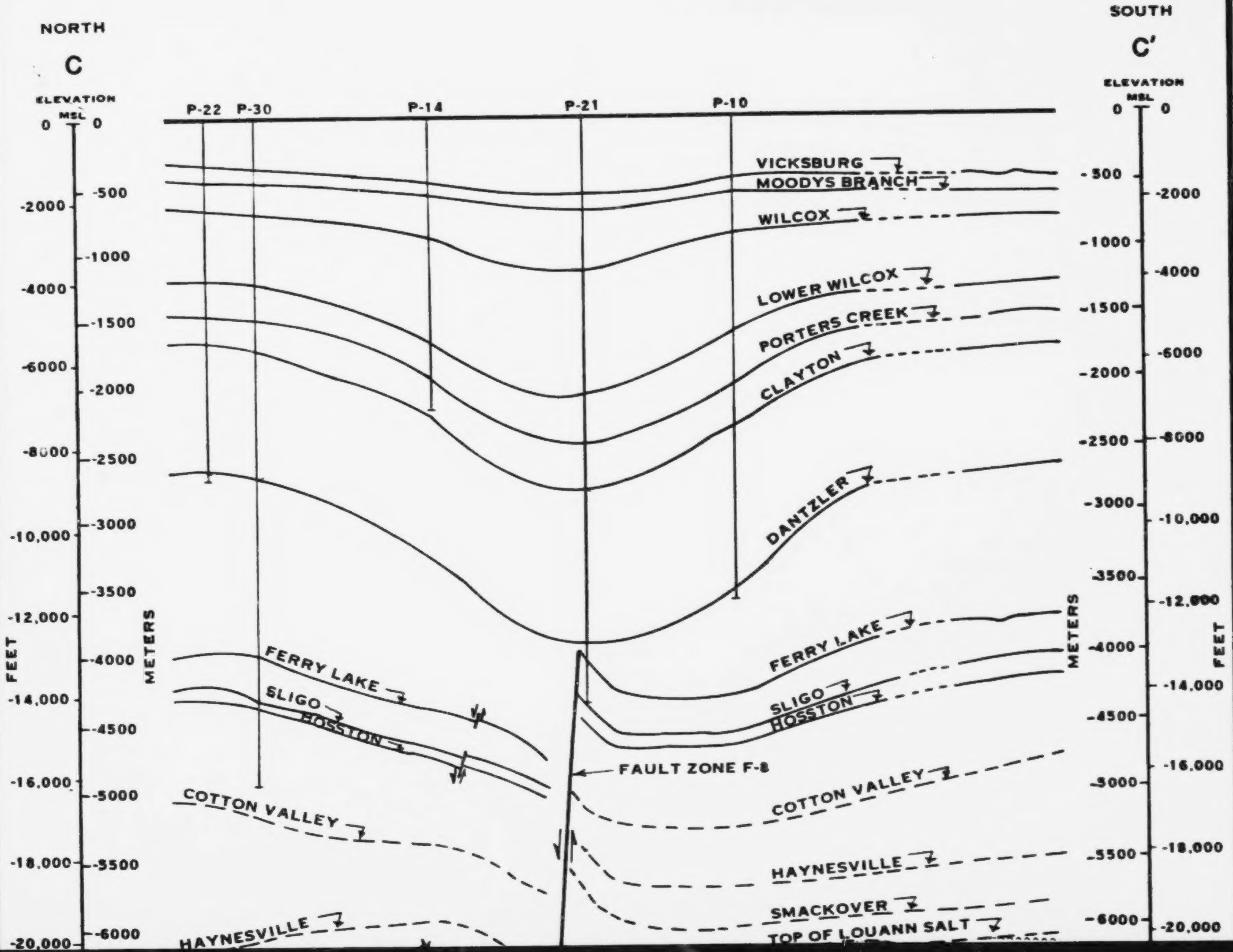
SEISMIC SECTION B-B'

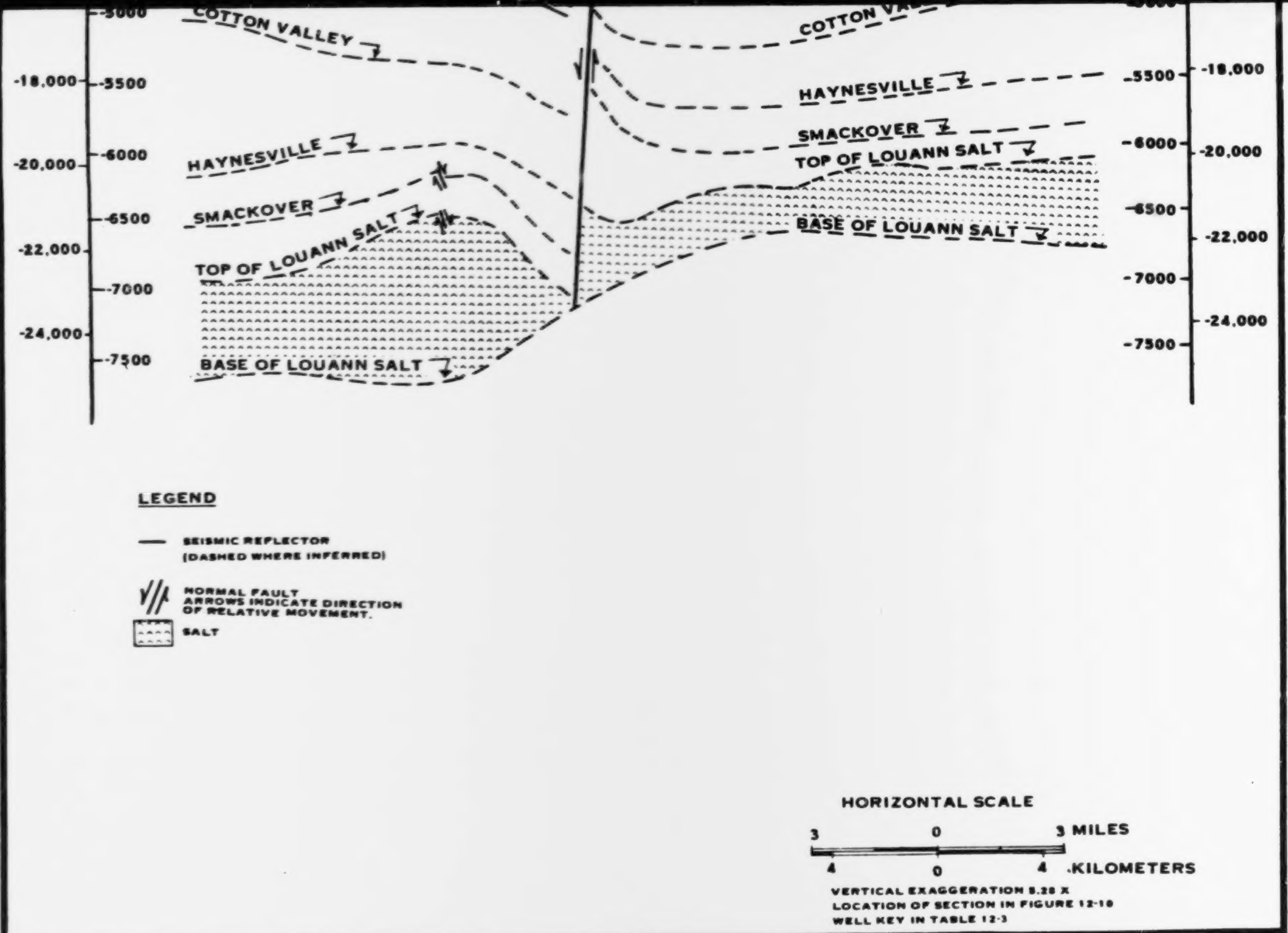
JOB NO. MV9600 FIGURE 12-26

BEST DOCUMENT AVAILABLE

DOCUMENT AVAILABLE

70


NORTH
C
ELEVATION
MSL
0
0
-500
-2000
-1000
-4000
-1500
-6000
-2000
-8000
-2500
-10,000
-3000
-3500
-12,000
FEET
-4000
METERS
-14,000
-4500
-16,000
-5000
-5500
-18,000
-6000
-20,000
P-22
P-30
P-14
P-21
P-10
VICKSBURG
MOODYS BRANCH
WILCOX
LOWER WILCOX
PORTERS CREEK
CLAYTON
DANTZLER
FERRY LAKE
SLIGO
HOSSTON
FERRY LAKE
SLIGO
HOSSTON
FAULT ZONE F-8
COTTON VALLEY
COTTON VALLEY
HAYNESVILLE
HAYNESVILLE
SMACKOVER
TOP OF LOUANN SALT
SOUTH
C′
ELEVATION
MSL
0
0
-500
-2000
-1000
-4000
-1500
-6000
-2000
-2500
-8000
-3000
-10,000
-3500
-12,000
METERS
-4000
FEET
-14,000
-4500
-16,000
-5000
-5500
-18,000
-6000
-20,000



-5000
COTTON VALLEY
-18,000
-5500
-20,000
-6000
HAYNESVILLE
-6500
SMACKOVER
-22,000
TOP OF LOUANN SALT
-7000
-24,000
-7500
BASE OF LOUANN SALT
COTTON VA
HAYNESVILLE
SMACKOVER
TOP OF LOUANN SALT
BASE OF LOUANN SALT
-5500
-18,000
-6000
-20,000
-6500
-22,000
-7000
-24,000
-7500
LEGEND
SEISMIC REFLECTOR
(DASHED WHERE INFERRED)
NORMAL FAULT
ARROWS INDICATE DIRECTION
OF RELATIVE MOVEMENT.
SALT
HORIZONTAL SCALE
3
0
3 MILES
4
0
4 KILOMETERS
VERTICAL EXAGGERATION 5.28 X
LOCATION OF SECTION IN FIGURE 12-18
WELL KEY IN TABLE 12-3

70A

PREPARED J.D.G DATE 8-15-80
REVISED DATE
REVISED DATE
APPROVED DATE
T-1439-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

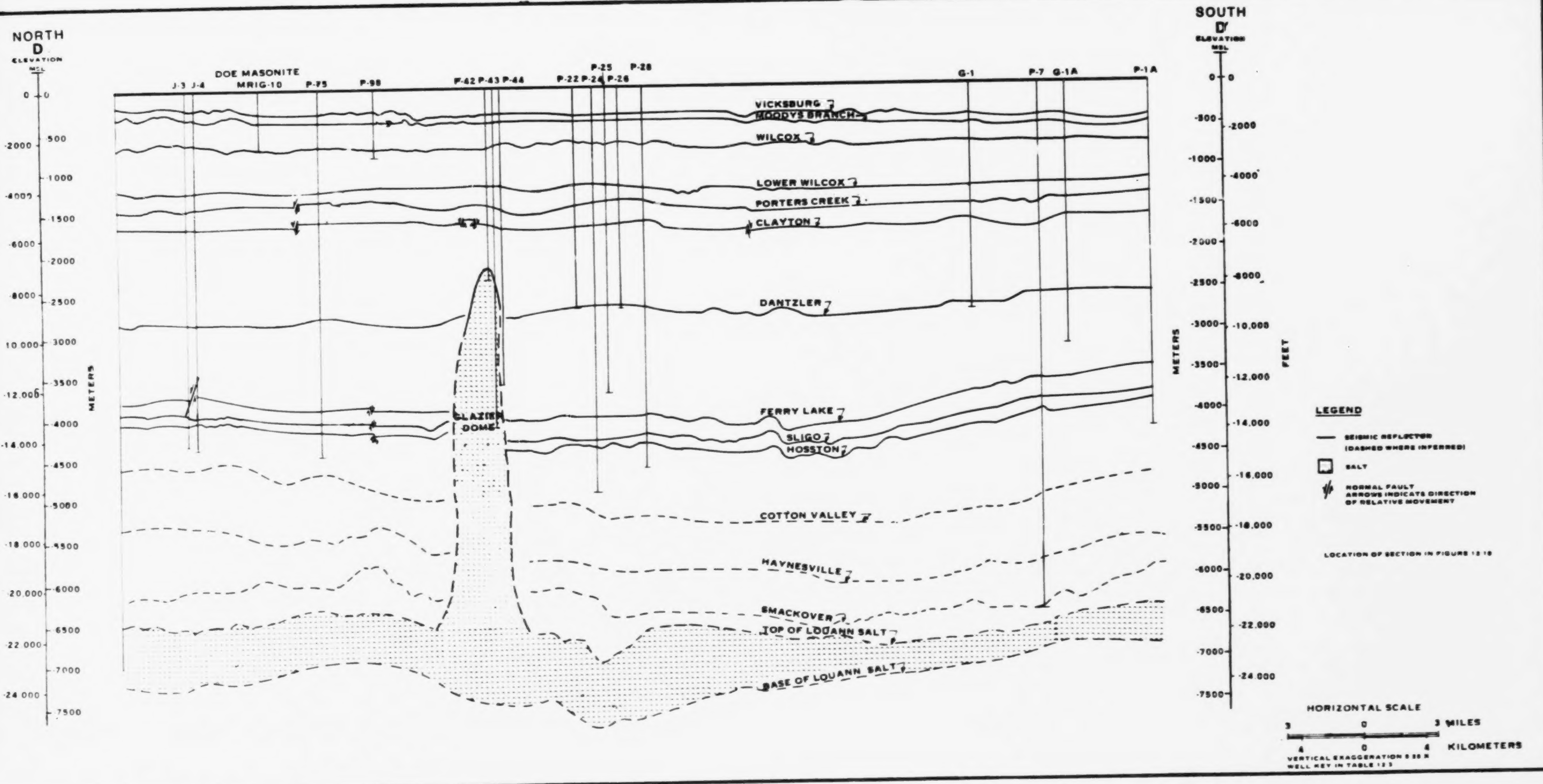
SEISMIC SECTION C-C'

JOB NO. MV9600

FIGURE 12-27

FIGURE 12-27

BEST DOCUMENT AVAILABLE


NORTH
D
ELEVATION
MSL
SOUTH
D'
ELEVATION
MSL
J-3
J-4
DOE MASONITE
MRIG-10
P-75
P-98
P-42
P-43
P-44
P-22
P-24
P-25
P-26
P-28
G-1
P-7
G-1A
P-1A
VICKSBURG
MOODYS BRANCH
WILCOX
LOWER WILCOX
PORTERS CREEK
CLAYTON
DANTZLER
GLAZIER DOME
FERRY LAKE
SLIGO
HOSSTON
COTTON VALLEY
HAYNESVILLE
SMACKOVER
TOP OF LOUANN SALT
BASE OF LOUANN SALT
FEET
METERS
0
-2000
-4000
-6000
-8000
-10,000
-12,000
-14,000
-16,000
-18,000
-20,000
-22,000
-24,000
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
LEGEND
SEISMIC REFLECTOR
(DASHED WHERE INFERRED)
SALT
NORMAL FAULT
ARROWS INDICATE DIRECTION
OF RELATIVE MOVEMENT
LOCATION OF SECTION IN FIGURE 12.18
HORIZONTAL SCALE
3
0
3 MILES
4
0
4
KILOMETERS
VERTICAL EXAGGERATION
WELL KEY IN TABLE 12.3

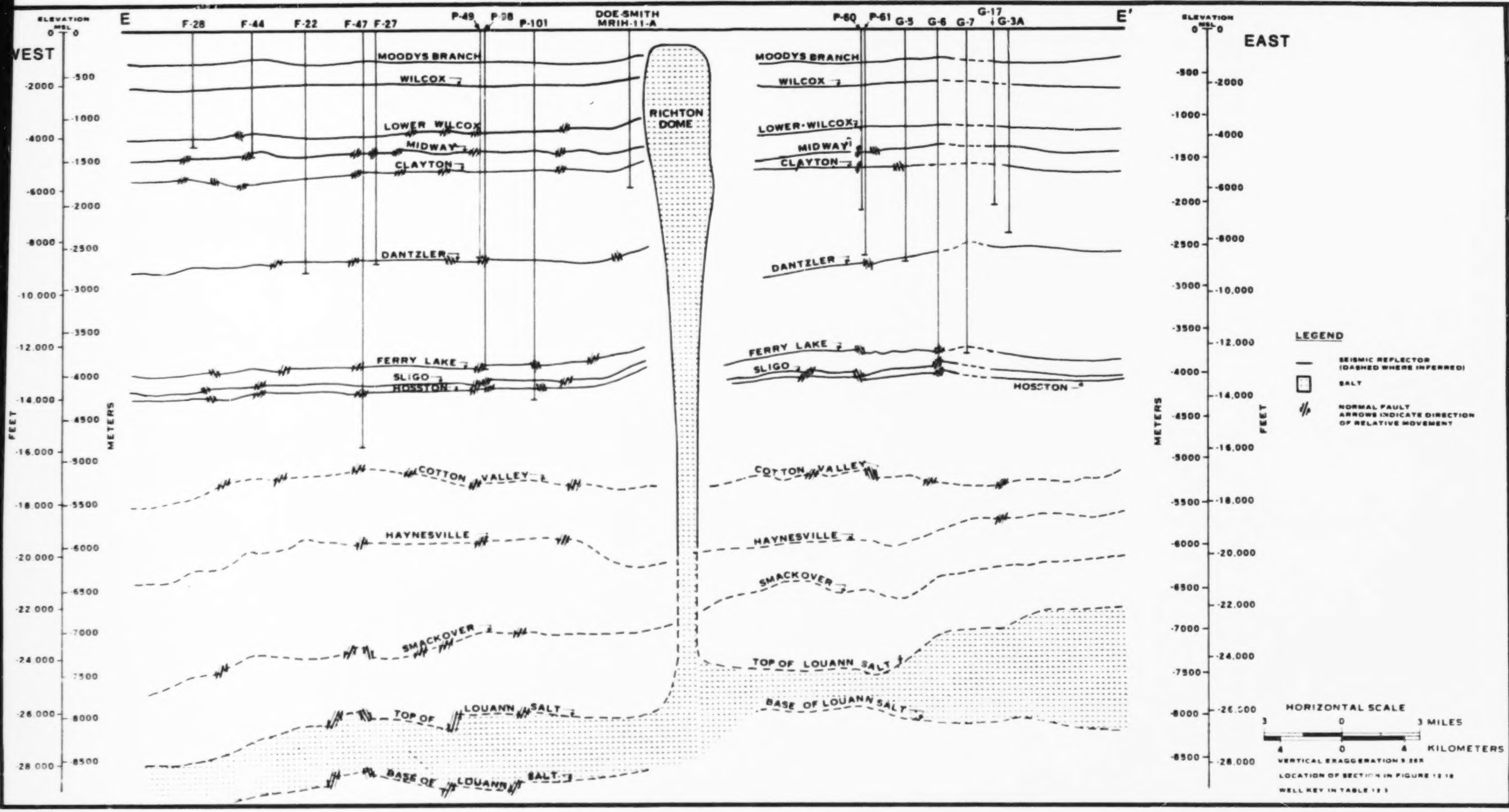
MISSISSIPPI STUDY AREA
SEISMIC SECTION D-D'
FIGURE 12-28
JOB NO. MV9600

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

PREPARED ______ DATE ______
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE ______
T-1440-1

FIGURE 12-28

BEST DOCUMENT AVAILABLE


E
E'
WEST
EAST
ELEVATION MSL 0
FEET
METERS
F-28
F-44
F-22
F-47
F-27
P-49
P-98
P-101
DOE-SMITH MRIH-11-A
P-60
P-61
G-5
G-6
G-7
G-17
G-3A
RICHTON DOME
MOODYS BRANCH
WILCOX
LOWER WILCOX
MIDWAY
CLAYTON
DANTZLER
FERRY LAKE
SLIGO
HOSSTON
COTTON VALLEY
HAYNESVILLE
SMACKOVER
TOP OF LOUANN SALT
BASE OF LOUANN SALT
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
-5000
-5500
-6000
-6500
-7000
-7500
-8000
-8500
-2000
-4000
-6000
-8000
-10,000
-12,000
-14,000
-16,000
-18,000
-20,000
-22,000
-24,000
-26,000
-28,000
LEGEND
SEISMIC REFLECTOR (DASHED WHERE INFERRED)
SALT
NORMAL FAULT ARROWS INDICATE DIRECTION OF RELATIVE MOVEMENT
HORIZONTAL SCALE
3
0
3 MILES
4
0
4
KILOMETERS
VERTICAL EXAGGERATION 5.28X
LOCATION OF SECTION IN FIGURE 12.18
WELL KEY IN TABLE 12.3

MISSISSIPPI STUDY AREA
SEISMIC SECTION E-E'
JOB NO. MV9600
FIGURE 12-29

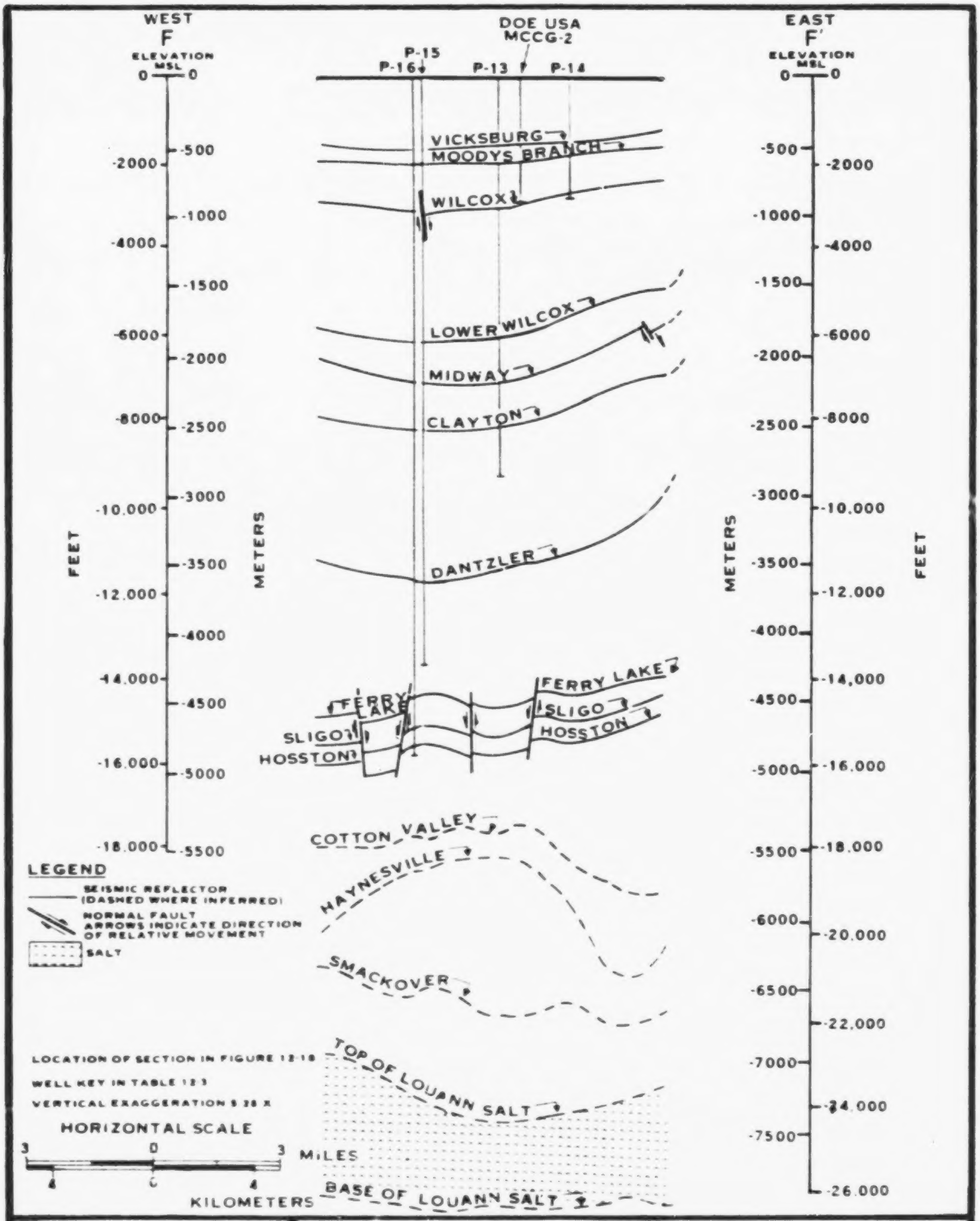
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

PREPARED DATE
REVISED DATE
REVISED DATE
APPROVED DATE
T-1441-1

FIGURE 12-29

72

BEST DOCUMENT AVAILABLE


WEST
F
ELEVATION MSL
EAST
F'
DOE USA MCCG-2
P-15
P-16
P-13
P-14
FEET
METERS
0
-2000
-4000
-6000
-8000
-10,000
-12,000
-14,000
-16,000
-18,000
-20,000
-22,000
-24,000
-26,000
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
-5000
-5500
-6000
-6500
-7000
-7500
VICKSBURG
MOODYS BRANCH
WILCOX
LOWER WILCOX
MIDWAY
CLAYTON
DANTZLER
FERRY LAKE
SLIGO
HOSSTON
COTTON VALLEY
HAYNESVILLE
SMACKOVER
TOP OF LOUANN SALT
BASE OF LOUANN SALT
LEGEND
SEISMIC REFLECTOR (DASHED WHERE INFERRED)
NORMAL FAULT ARROWS INDICATE DIRECTION OF RELATIVE MOVEMENT
SALT
HORIZONTAL SCALE
3
0
3
MILES
4
0
4
KILOMETERS

LOCATION OF SECTION IN FIGURE 12-18

WELL KEY IN TABLE 12-3

VERTICAL EXAGGERATION 5.28 X

PREPARED ____ DATE ____ REVISED ____ DATE ____ REVISED ____ DATE ____ APPROVED ____ DATE ____ T-1442-1	NATIONAL WASTE TERMINAL STORAGE PROGRAM GEOLOGIC EVALUATION GULF COAST SALT DOMES LAW ENGINEERING TESTING COMPANY MARIETTA GEORGIA	MISSISSIPPI STUDY AREA SEISMIC SECTION F-F' JOB NO MV9600 FIGURE 12-30

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 12-3
(PAGE 1 OF 6)

NAMES OF WELLS USED IN FIGURES

LETCO WELL NO.	WELL NAME	WELL LOCATION (SECTION-TOWNSHIP-RANGE)	GROUND LEVEL (ELEVATION IN FEET MSL)	TOTAL DEPTH (FEET)
F-7	Chevron USA-BLMA No. 1	29-1N-12W	278	11,515
F-22	Humble Griffin No. 1	4-4N-12W	*220	9,417
F-27	Duck & Hughes Herchenhahn No. 1	13-5N-12W	*237	9,005
F-28	Allied Chemical Fee Salt Water Disposal Well No. 2	14-5N-13W	166	3,111
F-44	Enterprise Salt Water Disposal Well No. 2	18-5N-12W	*270	4,975
F-47	Hunt & Forest Lee No. 1	23-5N-12W	238	16,120
G-1	General Crude Oil Greene No. 1	10-1N-8W	* 82	9,015
G-1A	Southern Natural Gas Co. McKay No. 1	25-1N-8W	* 63	10,600
G-3A	E. V. Cleveland Hubbard No. 1-A	10-4N-8W	*258	8,000
G-5	Tom McGlothlin-R. A. Moon-A. W. Williams Drlg. Oscar Waer No. 1	18-5N-8W	*218	8,874
G-6	Texaco Sam Henderson No. 1	29-5N-8W	*192	12,641
G-7	Humble J. A. Huret No. 1	33-5N-8W	201	12,328
G-17	Grace Kirby 4-8 No. 1	4-4N-8W	267	6,962
J-3	Union Oil Dennis et al No. 1	33-6N-10W	250	14,447
J-4	Union Oil USA No. 1	33-6N-10W	234	14,638
J-13	Ginther-Warren & Co. Sunset Int'l. Petro. Corp. No. 4 Shows	28-6N-11W	236	12,986
M-20	Exploro Corporation Bradshaw et al No. 4	17-3N-17W	317	1,412
M-21	Exploro Hurst No. 1	17-3N-17W	300	1,497

*Elevation of Drill floor

TABLE 12-3
(PAGE 2 OF 6)

NAMES OF WELLS USED IN FIGURES

LETCO WELL NO.	WELL NAME	WELL LOCATION (SECTION-TOWNSHIP-RANGE)	GROUND LEVEL (ELEVATION IN FEET MSL)	TOTAL DEPTH (FEET)
M-22	Exploro Bradshaw et al No. 5	20-3N-17W	231	3,000
M-23	Exploro Bradshaw No. 6	20-3N-17W	287	1,847
M-24	Exploro Bradshaw et al No. 1	20-3N-17W	326	2,995
M-25	Gulf Bradshaw et al No. 1	20-3N-17W	332	1,627
M-26	Exploro Bradshaw No. 8	20/21-3N-17W	259	1,515
M-27	Exploro Cook No. 1	20-3N-17W	352	3,000
M-28	Exploro Bradshaw No. 3	21-3N-17W	271	1,346
M-29	Exploro Bradshaw No. 2	21,3N-17W	324	1,649
M-30	Gulf Bradshaw No. 4	21-3N-17W	287	7,200
M-32	Gulf Bradshaw No. 2	27-3N-17W	242	9,241
M-33	Gulf Bradshaw No. 5	28-3N-17W	239	6,828
M-34	Exploro Bradshaw No. 7	28-3N-17W	224	1,465
M-35	Gulf Bradshaw No. 3	29-3N-17W	222	9,622
MCCG-1	DOE-USA MCCG-1	9-2N-10W	221	1,899
MCCG-2	DOE-USA MCCG-2	33-3N-10W	197	3,007
MCCH-3B	DOE-USA MCCH-3B	33-2N-10W	258	4,100
MRIG-9	DOE-Masonite MRIG-9	26-5N-10W	256	1,275
MRIG-10	DOE-Masonite MRIG-10	12-5N-10W	285	2,610
MRIH-11A	DOE-Smith MRIH-11A	9-4N-10W	180	6,041
P-1A	Florida Gas O'Neal No. 1	36-1S-9W	209	14,100
P-7	Continental Oil USA No. 1-A	25-1N-9W	176	21,559

*Elevation of Drill Floor

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 12-3
(PAGE 3 OF 6)

NAMES OF WELLS USED IN FIGURES

LETCO WELL NO.	WELL NAME	WELL LOCATION (SECTION-TOWNSHIP-RANGE)	GROUND LEVEL (ELEVATION IN FEET MSL)	TOTAL DEPTH (FEET)
P-10	Continental Oil Newman-USA No. 1	14-1N-10W	*265	11,957
P-11	Armer et al Drilling USA No. 1	32-1N-10W	156	5,010
P-12	Ohio Oil USA No. 1	17-1N-11W	133	10,000
P-13	Hunt & Whitaker USDA No. 1	18-1N-11W	*167	9,503
P-14	Courson et al Newman Lumber No. 2	2-2N-10W	*188	3,027
P-15	Shell Oil No. 1 USA No. 8-6	8-2N-10W	248	14,000
P-16	Shell Oil No. 1 USA No. 8-11	8-2N-10W	235	16,116
P-16A	Shell Oil USA No. 1	8-2N-10W	234	2,262
P-17	Shell Oil No. 1 USA No. 8-14	8-2N-10W	KB 261	13,900
P-18	Shell Oil No. 1 USA No. 10-5	10-2N-10W	232	16,300
P-19	Shell Oil No. 1 USA No. 17-6	17-2N-10W	226	16,500
P-20	Phillips Petroleum	21-2N-10W	210	8,434
P-21	Shell Oil No. 1 USA No. 26-11	26-2N-10W	225	14,459
P-22	Stanolind Oil & Gas Masonite No. 1	7-3N-9W	KB 195	9,045
P-24	Union Oil Breland No. 1	17-3N-9W	121	16,385
P-25	State Exploration Masonite No. 1	18-3N-9W	111	12,415
P-26	State Exploration Pipkins No. 1	20-3N-9W	97	9,016
P-28	Gulf Oil & Seaboard Oil Lot No. 1	27-3N-9W	94	15,380
P-30	McMoran Exploration Cannon No. 1	13-3N-10W	99	16,350

*Elevation of Drill Floor

TABLE 12-3
(PAGE 4 OF 6)

NAMES OF WELLS USED IN FIGURES

LETCO WELL NO.	WELL NAME	WELL LOCATION (SECTION-TOWNSHIP-RANGE)	GROUND LEVEL (ELEVATION IN FEET MSL)	TOTAL DEPTH (FEET)
P-33	McDermott Draughn No. 1	4-3N-11W	132	13,200
P-42	Union Producing Stevens No. A-4	20-4N-9W	*148	7,828
P-43	Union Cooper No. 1	29-4N-9W	121	13,768
P-44	Pelto Oil Richton Tie & Timber No. 1	29-4N-9W	112	12,015
P-47	Minsearch Fishel No. 1	1-4N-10W	225	979
P-48	Exploro Carey No. 2A	1-4S-10W	*202	2,000
P-49	Minsearch Carey No. 1	1-4N-10W	235	1,312
P-50	Minsearch Ridgeway B No. 12	2-4N-10W	234	873
P-51	Minsearch Pope No. 2	2-4N-10W	*261	1,591
P-52	Minsearch Pope No. 1	2-4N-10W	*206	583
P-53	Minsearch Carter No. 2	2-4N-10W	184	682
P-56	Young Drilling Smith Estate No. 1	25-4N-11W	*245	11,499
P-57	Temple-Crow Chancellor Lumber No. 1	29-4N-11N	207	8,919
P-58	Continental Oil Richton Tie & Timber No. 1	34-4N-11W	118	18,938
P-60	Merry Masonite No. 1	35-5N-9N	221	7,092
P-61	Evans McClain No. 1	36-5N-9W	*200	8,722
P-65	Shell Oil Masonite No. 1	14-5N-10W	241	12,969
P-66	Shell Oil Masonite No. 21-1	21-5N-10W	202	14,497
P-67	Exploro Masonite No. 9	22-5N-10W	*214	740
P-68	Exploro Masonite No. 7	22-5N-10W	*214	735
P-69	Exploro Masonite No. 3	22-5N-10W	*228	739

*Elevation of Drill Floor

BEST DOCUMENT AVAILABLE

TABLE 12-3
(PAGE 5 OF 6)

NAMES OF WELLS USED IN FIGURES

LETCO WELL NO.	WELL NAME	WELL LOCATION (SECTION-TOWNSHIP-RANGE)	GROUND LEVEL (ELEVATION IN FEET MSL)	TOTAL DEPTH (FEET)
P-70	Exploro Masonite No. 1	22-5N-10W	*258	856
P-71	Exploro Masonite No. 8	22-5N-10W	*247	765
P-72	Exploro Masonite No. 4	23-5N-10W	*244	772
P-73	Exploro Masonite No. 6	23-5N-10W	*202	632
P-74	Exploro Masonite No. 5	23-5N-10W	*213	970
P-75	Shell Oil Masonite No. 23-7	23-5N-10W	251	14,930
P-76	Exploro Masonite No. 2	25-5N-10W	239	1,865
P-77	Exploro Ridgway No. B-11	26-5N-10W	*223	640
P-78	Minsearch Rich et al No. 1	26-5N-10W	238	872
P-79	Exploro Ridgway No. B-3	26-5N-10W	*253	730
P-80	Exploro Masonite No. 10	26-5N-10W	*277	713
P-81	Minsearch Ridgway No. B-6	27-5N-10W	*222	765
P-82	Minsearch Ridgway No. B-7	27-5N-10W	*235	775
P-83	Exploro Ridgway No. B-5	27-5N-10W	*246	682
P-84	Exploro Ridgway No. B-1	27-5N-10W	*229	675
P-85	Gulf Stevens No. 1	28-5N-10W	177	8,873
P-87	Minsearch Ridgway No. B-8	34-5N-10W	*217	779
P-88	Minsearch Smith No. 1	34-5N-10W	*285	1,050
P-89	Minsearch Ridgway No. B-9	34-5N-10W	*243	2,601
P-90	Exploro Ridgway No. B-2	34-5N-10W	217	899
P-91	Minsearch Ridgway No. B-4	34-5N-10W	NOT AVAILABLE	

*Elevation of Drill Floor

TABLE 12-3
(PAGE 6 OF 6)

NAMES OF WELLS USED IN FIGURES

LETCO WELL NO.	WELL NAME	WELL LOCATION (SECTION-TOWNSHIP-RANGE)	GROUND LEVEL (ELEVATION IN FEET MSL)	TOTAL DEPTH (FEET)
P-92	Minsearch Ridgway No. B-10	35-5N-10W	*242	717
P-93	Exploro Carter No. 1	25-5N-10W	*228	700
P-94	Minsearch Backstrom No. 2	36-5N-10W	*247	722
P-95	Minsearch Cantrell Est. No. 1	36-5N-10W	*262	935
P-96	Minsearch Backstrom No. 1	36-5N-10W	*217	3,000
P-97	Jett Drilling & Southern Fuels Reasor No. 1	4-5N-11W	*236	7,815
P-98	Gulf Oil Runnelstown No. 1 16-9	16-5N-11W	*218	13,019
P-99	Cox & Hamon Masonite No. 1	21-5N-11W	250	9,020
P-101	Pan American Petroleum Powe No. 1	24-5N-11W	*239	14,199
P-102	Humble Oil & Refining Revet No. 1-A	7-4N-10W	154	2,401
P-103	Jones-O'Brien Cox No. 1	19-3N-11W	236	17,000

*Elevation of Drill Floor

BEST DOCUMENT AVAILABLE

top of the Dantzler. The relationship of this fault, (F-8, discussed in Section 12.2.3.4.5.8) to the Perry Basin is unclear.

Seismic Section B-B' (Figure 12-26) illustrates a similar basin configuration. It shows downwarping of the strata and decreasing structural relief on progressively younger horizons. A normal fault is inferred to displace beds from the Smackover to the top of the Dantzler. Displacement along this fault is less than that of Fault Zone F-8 (Figure 12-27). These two faults displace similar stratigraphic intervals, are both downthrown to the north, and are probably related.

During Cenozoic time, the thickest accumulation of sediments within the study area was in the Perry Basin. The sediments thinned to the south, farther from the source of clastics. Analyses of purchased seismic data, as well as structural contour maps on the tops of Cretaceous through Tertiary units, indicate that the basin began to subside during deposition of the Paleocene-Eocene Wilcox Group. Subsidence continued through the deposition of the Moodys Branch Formation and began to decrease in Oligocene time. Basin expression is still evident on top of the Vicksburg Limestones although it is not as prominent as on the underlying beds. Subsidence in the basin may have continued into the Miocene.

Fault Zone F-8 (Figure 12-12) is located approximately beneath the axis of the Perry Basin. By comparing the thicknesses of stratigraphic intervals on either side of the fault, it is possible to infer a time for fault inception, maximum movement, and cessation (Thorsen, 1963). Based on analyses of seismic reflection data (Figure 12-27) it appears that displacement along Fault Zone F-8 first occurred during deposition of the Smackover Formation and ended prior to development of the Perry Basin in the Paleocene. Maximum displacement of the beds probably occurred during Haynesville deposition, and movement apparently ceased in the Early Cretaceous.

The proximity of Cypress Creek Dome to the Perry Basin suggests the possibility that the basin is a salt withdrawal feature. One explanation is that the faulting beneath the basin is the result of pillowing of the salt into a low-relief salt anticline. Salt subsequently migrated laterally and vertically to form a salt pillar. As a result, subsidence of the strata occurred over the location of the former salt ridge, thus forming the Perry Basin.

12.2.3.3 Wiggins Anticline: The Wiggins Anticline is the name assigned to the northern element of the Wiggins Uplift, which is an irregular, partly arcuate, bifurcated positive feature extending from southwestern Alabama into southeastern Mississippi (Murray, 1961). Located just south of the study area, the axis of the Wiggins Anticline trends N 80° West (Eargle, 1968) through northern Stone, Pearl River, and George Counties and southern Forrest County (Figures 12-5 and 12-12), and it is thought to be related to the Perry Basin by a cause-and-effect relationship (Murray, 1961; Williams, 1967).

The Wiggins Anticline is bordered on the north by a slightly arcuate east-trending normal fault, the Pistol Ridge-Maxie Fault

(Figure 12-12). Northeast of the Wiggins Anticline, the strata dip steeply northward into the Perry Basin (Eargle, 1968). South of the study area, the structure plunges to the west. The westward extent of the structure is unknown.

The origin of the Wiggins Anticline has been a matter of conjecture. Williams (1967) proposed that, prior to attaining anticlinal configuration, the present Wiggins Anticline area was relatively stable compared to that of the Perry Basin. During the Mesozoic and early Tertiary, thick accumulations of sediments were deposited in the basin and subsidence developed the northerly dip of the northern flank of the Wiggins Anticline. By late Tertiary time, the center of deposition shifted southward, causing subsidence south of the present Wiggins Anticline, accompanied by a southward tilting of previously near-horizontal beds to form the southern limb of the Wiggins Anticline.

An alternative interpretation (Worzel and Watkins, 1973) associates the Wiggins Anticline and its southern extension, the Hancock County High, with an underlying basement uplift which separates the Mississippi Salt Basin from the Coastal Salt Basin. Gravity and seismic refraction data indicate that the crest of the basement uplift is situated beneath the Hancock County High, whereas the Wiggins Anticline overlies the northern slope of the structure (Warren and others, 1966). Worzel and Watkins (1973) suggest that southward movement of the continental crust during Mesozoic time stretched and thinned the crust underlying the Mississippi Salt Basin. The development of a basement uplift could have restricted circulation of seawater to the north of the

Hancock County High, thereby creating conditions necessary for evaporite deposition. Although salt was not deposited on the axis of this basement high, well data indicate that salt is present over its northern flank (Applin and Applin, 1953). The Wiggins Anticline subsequently developed when sediment loading mobilized the salt on the northern flank of the basement uplift, causing deformation of the overlying sediments.

12.2.3.4 Faults: Faulting within the Mississippi Study Area is characterized by normal (gravity) displacement, and the majority of known faults may be attributed to movement of the Louann Salt. The dominant trend of the strike of the fault planes in the area is to the southeast-northwest (Figure 12-12). However, several major deviations from this trend are seen locally in the radial fault pattern adjacent to the salt domes and in the east-west-trending Pistol Ridge-Maxie Fault and the north-south-trending Phillips Fault System. Two large oil and gas fields within the study area, Hub and Baxterville, are highly faulted, anticlinal traps thought to have formed by deep-seated salt structures. The remaining faults have been interpreted from structure contour maps and seismic data within the study area.

12.2.3.4.1 Pistol Ridge-Maxie Fault - The Pistol Ridge-Maxie Fault is an arcuate, normal fault trending generally east-west and located approximately 10 km (6 mi) south of the study area (Figure 12-12). It extends through southern Forrest and Pearl River Counties, Mississippi, and can be traced for a distance of approximately 23 km (14 mi). The fault is convex southward and downthrown to the north. The closest distance between the Pistol Ridge-Maxie Fault and each of the domes at Lampton, Richton, and Cypress Creek is approximately 37, 43, and 21 km (23, 27, and 13 mi), respectively.

The Pistol Ridge-Maxie Fault borders the northern flank of the Wiggins Anticline and has a throw of at least 76 meters (250 ft) on top of the Lower Cretaceous. Displacements on the fault decrease stratigraphically upward, with the maximum throw being slightly more than 30 meters (100 ft) on top of both the Clayton Formation and the Wilcox Group. Structural interpretation indicates that the fault affects the Tatum Limestone member of the Miocene Catahoula Formation, where it has a throw of less than 30 meters (100 ft) (Eargle, 1968). It has not been recognized in younger sediments.

12.2.3.4.2 Phillips Fault System - The Phillips Fault System is a prominent north-south-trending normal fault system extending from Attala County southward into northern Greene County, Mississippi. From subsurface well control and gravity interpretation, Oxley and others (1968) assumed that this fault system is a series of en echelon normal faults with downthrown blocks to the south and west. The southern identifiable limit of the system is just south of the Newton-Jasper County line, where it passes beneath the Louann Salt (Oxley and others, 1968). Oxley and others (1968) postulate that fault displacement beneath the salt is manifested in linear ridges in the salt. One of these ridges, the

Heidelberg-Sand Hill Salt Ridge, extends from Green County northward into Jasper County (approximately 80 km (50 mi)). Its northern extremity trends towards the southernmost recognized limits of the Phillips Fault System. Consequently, the Phillips Fault System is believed to underlie the Heidelberg-Sand Hill Salt Ridge along its entire length (Oxley and others, 1968). Overlying the ridge is a complex graben that extends upward from Jurassic through Eocene strata (Hughes, 1960), discussed in Section 12.2.3.4.5.9.

The fault system is postulated by Oxley and others (1968) to be present in the extreme northeastern corner of the Mississippi Study Area in northeastern Perry County (Figure 12-12). Its closest proximity to Lampton, Richton, and Cypress Creek Salt Domes is approximately 82, 8, and 24 km (51, 5, and 15 mi), respectively. Seismic section E-E' (Figure 12-29) crosses the trend of the fault system and shows no displacement of the Louann Salt or younger strata.

Oxley and others (1968) described the fault:

> The age of occurrence of the Phillips Fault System is uncertain. Stratigraphic evidence indicates that it moved intermittently during Jurassic time. From regional tectonic patterns and subsurface structural interpretations it is assumed that it post-dates the earliest Appalachian folding in the area. The curvature of the Paleozoic folds closest to the Phillips Fault System indicates the possibility of a strike-slip component. A maximum amount of fault throw as evidenced by missing sections in several wells would include a fraction of the Ordovician, all of the Silurian, Devonian, Mississippian, Pennsylvanian and part of the Jurassic. This could amount to over 3,048 meters (10,000 ft) of throw; however, it is unlikely that this much vertical displacement was ever in existence at one time.

Murray (1961) describes an irregularly oriented graben system that trends through Scott, Smith, Jasper, Jones, Wayne, and Greene Counties, Mississippi. These grabens were apparently related to "undetermined regional forces associated with movements of the Ouachita and Appalachian orogenic belts" (Murray, 1961). However, there is insufficient information to relate the irregularly oriented grabens discussed by Murray (1961) to the Phillips Fault System of Oxley and others (1968).

Morgan (1970) concedes that the loss of the pre-Lower Cretaceous section, indicated by Oxley and others (1968), could be interpreted as fault-controlled on the basis of subsurface data alone. However, Morgan presents four seismic profiles across the fault zone in northern Mississippi that indicate most of the loss of section is caused by rapid thinning and updip convergence of beds. "Some faulting may be present, but it is minor" (Morgan, 1970). This area represents the northeastern edge of the Mississippi Interior Salt Basin.

12.2.3.4.3 Hub Field - Hub Field is located in the southwestern corner of the Mississippi Study Area in Marion County (Figure 12-12). The structure controlling the field is an elongate, doubly plunging anticline (Knight, 1951; Arledge, 1957). Structural contours of the top of the Lower Tuscaloosa show that faults form a northerly trending graben over the center of the anticline (Figure 12-23). The closest occurrences of faults in the Hub structure to Lampton, Richton, and Cypress Creek Salt Domes are approximately 8, 79, and 71 km (5, 49, and 44 mi), respectively.

The faults in the Hub structure are all of normal displacement, varying in throw between 6 and 52 meters (20 and 170 ft), with an average throw of 20 meters (65 ft). The main fault is located on the western side of the structure and is approximately 4 km (2.5 mi) long. It trends northwesterly and the strata are downthrown to the northeast with a throw of 52 meters (170 ft). The southern portion of this fault arcs in a southwesterly direction (Arledge, 1957). The eastern boundary fault consists of a series of interconnecting faults on the northern and eastern flanks of the central graben. Faulting in this system is continuous for approximately 5.6 km (3.5 mi), and the general trend of the fault system is northwesterly. Displacement along this zone is between 18 and 24 meters (60 and 80 ft) to the southwest. Two other faults branch off the eastern boundary fault. One of these faults trends due south, then turns sharply to the southeast and joins the main fault. This fault displaces strata to the east and forms a downthrown block within the main graben. The second branch trends northerly from the eastern boundary fault, and strata are downthrown approximately 23 meters (75 ft) to the west. Faulting on the Hub structure is apparent on structural maps of the top of the Lower Tuscaloosa and horizons as young as the top of the Clayton Formation, and it is thought to die out in the Wilcox Group (Knight, 1951).

The anticlinal structure of the Hub Field is believed to be the result of deep-seated salt structure (Knight, 1951 and Arledge, 1957). This conclusion is substantiated by the existence of a strong negative Bouguer gravity anomaly over the field

(Arledge, 1957). However, there are no well data to support this conclusion because the deepest well in the area did not penetrate salt.

12.2.3.4.4 Baxterville Field - Baxterville Field, located in the southwestern portion of the Mississippi Study Area, lies 13 km (8 mi) southeast of the Hub Field in eastern Marion and western Lamar Counties. The structure underlying the field is a large, complexly faulted, elongate anticline (Figure 12-24) (Davis and Lambert, 1963). The closest proximity of faults in the Baxterville structure to Lampton, Richton, and Cypress Creek Domes is approximately 14, 66, and 55 km (9, 41 and 34 mi), respectively.

Structural contours on top of the Davis Sand member of the Lower Tuscaloosa Formation show a complexly faulted domal structure at Baxterville Field (Figure 12-24). The dominant fault trend in the field is north-northeasterly, and strata are generally downthrown toward the west-northwest. One fault, with the downthrown block to the southeast, creates a small graben on the southwestern flank of the domal structure. Several other faults trend easterly. Using Halbouty's (1979) classification of fault structures, the overall fault pattern can be described to form compound offsets. Beds in this faulted structure typically are displaced 76 meters (250 ft) or less. Westward dipping faults dissipate stratigraphically upwards and die out in the Selma Group, while those dipping eastward die out in the Midway and Wilcox Groups.

As at Hub Field, the structure at the Baxterville Field is the result of deep-seated salt structure (Johnson, 1951; Davis and Lambert, 1963). The geometry of the central graben is thought to be indicative of salt movement at depth translated upward as tensional forces (Johnson, 1951).

12.2.3.4.5 LETCo Interpreted Faults - Figure 12-12 depicts structural features within the Mississippi Study Area. The Phillips Fault System, Pistol Ridge-Maxie Fault, and those faults shown within Hub and Baxterville Fields are based on data from the geologic literature. The remaining faults shown on Figure 12-12 were interpreted from structure contour maps based on well data from oil and gas exploration wells, wells drilled for the Area Characterization study, and on interpretations of CDP seismic-reflection data by LETCo personnel.

Fault zones interpreted from well data are designated roughly from west to east, F-1 through F-10. Individual faults within the zone have been assigned a letter suffix.

The faults discussed in this section are representative of the types to be found in the study area, though they cannot be considered to be all-inclusive. Detailed studies of local salt-controlled structures indicate numerous faults typical of those in Hub and Baxterville Fields, discussed previously in Sections 12.2.3.4.3 and 12.2.3.4.4, respectively. This type of faulting can be seen on several of the seismic reflection lines (Figures 12-25 through 12-30) but it is not discussed in this section. These faults seem to form at the time salt movement occurs, and they cease when the salt stabilizes.

Of greater importance are regional faults that may extend from one structure to another and which are therefore independent of local salt movements. No regional faults were identified from the interpretation of seismic and well data.

12.2.3.4.5.1 Fault Zone F-1: Fault Zone F-1 is located on the southeastern flank of Lampton Dome and consists of at least four distinct faults. These faults have been interpreted from missing stratigraphic sequences in two wells adjacent to the dome flank. Faulting in this area has been identified in the Wilcox, Selma, and Tuscaloosa Groups. A major fault with approximately 427 meters (1,400 ft) of throw is present in the Upper Wilcox Group. A second fault within the Wilcox Group has approximately 91 meters (300 ft) of throw and it may be antithetic to the larger fault. Two additional faults have been identified in the Selma and Tuscaloosa Groups with displacements of approximately 61 and 183 meters (200 and 600 ft).

There are insufficient well data in this area to determine the orientation and extent of Fault Zone F-1. However, it is evident from the existing well data that the faulting occurs within at least 305 meters (1,000 ft) of the Lampton Dome salt stock.

12.2.3.4.5.2 Fault Zone F-2: In the northwestern corner of Forrest County, a northwesterly trending fault is mapped on the top of the Lower Tuscaloosa (Figure 12-13). The fault is based on a missing interval in only one well, and is inferred to extend for approximately 5.6 km (3.5 mi). The closest approach of Fault F-2 to Lampton, Richton, and Cypress Creek Domes is approximately 35, 35, and 42 km (22, 22, and 26 mi), respectively.

The top of the Lower Tuscaloosa is downthrown to the northeast approximately 24 meters (80 ft) along Fault F-2. Faulting does not appear to extend above the Lower Tuscaloosa, indicating that movement ceased in Upper Cretaceous time. There is insufficient control to determine how deep the faulting extends.

Fault F-2 is not located in the immediate vicinity of a piercement salt dome and there is no evidence to suggest that faulting was caused by stresses created by salt movement.

12.2.3.4.5.3 Fault Zone F-3: Two radial faults (F-3A and F-3B) have been identified on the southwestern flank of Tatum Dome from structure contours on top of the Selma Group (Figure 12-14). Fault F-3A trends southwesterly for approximately 2.4 km (1.5 mi) from the edge of the salt stock, and strata are downthrown to the southeast approximately 274 meters (900 ft). Fault F-3B trends subparallel to F-3A for approximately 2.9 km (1.5 mi), and strata are downthrown nearly 122 meters (400 ft) to the northwest. The closest occurrence of these faults to Lampton, Richton, and Cypress Creek domes is approximately 13, 58, and 51 km (8, 36, and 32 mi), respectively.

The proximity of these faults to Tatum Dome suggests that they are the result of tensional stresses created by movement of the salt stock. Faulting in this zone has been observed only on the top of the Selma Group, which suggests that it occurred no later than Late Cretaceous time.

12.2.3.4.5.4 Fault Zone F-4: In the southeastern portion of Lamar County and continuing into southwestern Forrest County, a prominent arcuate fault is mapped on the top of the Lower Tuscaloosa (Figure 12-13). This fault is interpreted on the basis of missing sections in several wells. The closest portion of Fault F-4 to Lampton, Richton, and Cypress Creek domes is approximately 26, 37, and 23 km (16, 23, and 14 mi), respectively.

The fault is inferred to extend for approximately 19 km (12 mi), and its trend is from northwesterly to westerly. Structural contours on top of the Lower Tuscaloosa indicate that strata are downthrown from 18 to 46 meters (60 to 150 ft) to the northeast and north.

Fault F-4 does not appear on the top of the Selma, indicating that faulting ceased before the end of Late Cretaceous time. Data are not sufficient to determine the extent of faulting below the Lower Tuscaloosa. The cause of this faulting is not clear, but it may be related to a deep salt ridge.

12.2.3.4.5.5 Fault Zone F-5: A prominent southeasterly trending fault system in the Sunrise Dome area of northern Forrest County is evident on structure contour maps on the tops of the Lower Tuscaloosa, Selma, and Porters Creek units (Figures 12-13 through 12-15). The closest occurrence of this fault system to Lampton, Richton, and Cypress Creek Domes is approximately 47, 18, and 19 km (29, 11, and 12 mi), respectively.

The system consists of a northwesterly trending main fault, F-5A, which can be mapped for 10.4 km (6.5 mi) on the tops of the

Lower Tuscaloosa and Selma sequences. The strata are downthrown to the northeast approximately 396 meters (1,300 ft) on the top of the Lower Tuscaloosa. The amount of displacement decreases stratigraphically upward to approximately 183 meters (600 ft) on the top of Selma, and 30 meters (100 ft) on top of the Porters Creek Formation. The fault is not apparent on structure contours for the top of the Wilcox Group.

A second fault in this system, F-5B, is apparent on structure maps for the top of the Selma and Porters Creek. This fault is not evident on the Lower Tuscaloosa, possibly because of lack of well control. Fault F-5B branches south-southeasterly for approximately 7.2 km (4.5 mi) from the main fault. The strata are downthrown to the east; displacement is as much as 30 meters (100 ft) on the top of the Selma and Porters Creek. There is no evidence of faulting on the top of the Wilcox.

Initial movement on this system probably occurred no later than the time of deposition of the Lower Tuscaloosa, as indicated by a greater displacement in the underlying sequences. Because of a lack of deep well control in this area, the inception of faulting cannot be determined, but movement in the zone can be demonstrated to have continued through the Cretaceous into the Paleocene.

The proximity of this fault system to Sunrise Dome suggests that faulting is the result of tensional stresses created by salt movement.

12.2.3.4.5.6 Fault Zone F-6: In the southeastern portion of Forrest County, a northwesterly trending fault is mapped on the tops of the Lower Tuscaloosa and Selma (Figures 12-13 and 12-14). Fault F-6 is located on the western margin of the Perry Basin. The closest approach of this fault to Lampton, Richton, and Cypress Creek domes is approximately 53, 31, and 13 km (33, 19, and 8 mi), respectively.

Fault F-6 is approximately 6 km (4 mi) long and the northeastern block is downthrown almost 43 meters (140 ft) on the top of the Lower Tuscaloosa. Displacement decreases to 30 meters (100 ft) on the top of the Selma, and faulting is not apparent above the Selma.

Initial movement on this fault probably occurred no later than the time of deposition of the Lower Tuscaloosa. However, lack of deep well data prevents determination of the time of fault inception. It appears that faulting ceased during Late Cretaceous or early Paleocene time.

The position of this fault on the margin of the Perry Basin suggests that it may be the result of flexure caused by the downwarping of sediments in the basin.

12.2.3.4.5.7 Fault Zone F-7: On the northwestern flank of Richton Dome, a north-northwesterly trending fault (F-7) is depicted as intersecting the dome edge and extending radially away from it. This fault is apparent from structural contours on the top of the Lower Tuscaloosa and Selma units, and it is inferred to continue up through the Porters Creek (Figures 12-13 through

12-15). Faulting is not evident above the Porters Creek Formation; however, this may result from a lack of data for the younger stratigraphic sequence in this area. Whereas the fault is adjacent to Richton Dome, its closest approach to Lampton and Cypress Creek Domes is approximately 68 and 24 km (42 and 15 mi), respectively.

This fault can be mapped for approximately 16 km (10 mi) on the Lower Tuscaloosa, but it can be traced for only 11 and 10 km (7 and 6 mi) on the tops of the Selma and Porters Creek, respectively. The fault block is downthrown to the east-northeast, and the maximum displacement varies from approximately 229 meters (750 ft) on the top of the Lower Tuscaloosa to 61 meters (200 ft) on the top of the Porters Creek.

Faulting in this area continued at least until the end of the Cretaceous, and possibly into the Paleocene. Faulting was active during the Early Cretaceous, and some well data suggest that faulting may have affected Ferry Lake strata contemporaneously with deposition.

The proximity of this fault to Richton Dome suggests that faulting is caused by the movement of salt. Its great length at depth and its alignment with Richton and Glazier Domes help confirm the existence of a deep, northwesterly trending, linear salt ridge underlying the two domes. This ridge is discussed in Section 13.3.1.

12.2.3.4.5.8 Fault Zone F-8: On the southeastern flank of Cypress Creek Dome, faulting has been recognized from the existence of missing sequences in four wells and from analyses of purchased CDP seismic reflection records. Seismic data indicate the existence of a large normal fault, with the downthrown block to the north being displaced between approximately 518 and 792 meters (1,700 and 2,600 ft) (Figure 12-27). The fault affects Jurassic and Cretaceous sediments, and it may extend into the pre-salt basement. However, the quality of the seismic data at the depth of the Louann Salt is insufficient for conclusive interpretation. Faulting of the same magnitude as that observed on the seismic lines has been identified in the Middle Tuscaloosa in a nearby well.

Additional interpretation of seismic data near Cypress Creek Dome indicates a fault which affects Jurassic through Cretaceous sediments (Figure 12-26). It is possible that this is the same fault as that described above; however, the interpreted displacement along this fault is less. Strata across the fault are downthrown to the north approximately 274 meters (900 ft). Faulting has not been interpreted above the Dantzler Formation and it is questionable below the Hosston. This fault is located beneath the salt overhang of Cypress Creek Dome, thus making accurate seismic interpretation difficult, if not impossible.

Approximately 5.6 km (3.5 mi) south of the fault interpreted from seismic data, another well penetrates a fault with approximately 488 meters (1,600 ft) of throw in the Wilcox Group. This fault has been determined to be a separate and distinct fault from that interpreted from seismic data. Although it appears to be downthrown to the north, the extent and orientation of faulting are unknown.

In addition to these two large faults, several other faults have been identified in two nearby wells. These faults are in the lower portion of the Wilcox Group and in the Middle Tuscaloosa Formation; they have displacements on the order of 152 meters (500 ft). They may be compensatory, antithetic faults to the larger faults. However, data are insufficient in this area to determine their orientation and geometry accurately.

12.2.3.4.5.9 Fault Zone F-9: In the northeastern portion of Perry County, the southwestern portion of Wayne County, and the northwestern portion of Greene County, a northerly trending fault system is identifiable on the tops of the Lower Tuscaloosa and Selma (Figures 12-13 and 12-14). This system is composed of two parallel faults, F-9A and F-9B, which form a major graben. The closest approach of Fault Zone F-9 to Lampton, Richton, and Cypress Creek domes is approximately 79, 8, and 23 meters (49, 5, and 14 mi), respectively.

Fault F-9A, the westernmost fault, can be traced for approximately 35 km (22 mi) on the top of the Lower Tuscaloosa. Displacement of the eastern, downthrown block is as much as 244 meters (800 ft). Fault F-9B, the easternmost fault, is approximately parallel to fault F-9A and can be traced for almost 31 km (19 mi) on the top of the Lower Tuscaloosa. The western block is downthrown a maximum of approximately 213 meters (700 ft). On the top of the Selma, both of these faults are of lesser length and throw. They have not been identified above the Selma Formation. However, Seismic Section E-E' (Figure 12-29) does not show any major offsets in this area.

Faulting in this area controls petroleum accumulation in Sand Hill and North Sand Hill Fields and appears to have ceased during the Paleocene. Some evidence suggests the faulting began during deposition of the Ferry Lake Formation (Early Comanchean time). However, lack of sufficient data precludes exact determination of the inception of faulting. This fault system is believed to overlie a deep-seated salt ridge (Frascogna, 1957).

At the extreme northern end of the F-9 graben in Jasper County, Mississippi, faulting controls petroleum accumulation in Heidelberg Field. Hughes (1960) described this strucure in detail. It consists of a set of principal or primary faults similar to (and probably the same as) F-9A and F-9B which form a primary graben. These faults affect Smackover through Wilcox strata and they terminate against a salt uplift. Numerous subsidiary faults, which trend parallel to the principal faults, are located within the primary graben. These subsidiary faults terminate against larger ones at depth.

The graben described by Hughes in Jasper County trends southward almost continuously for approximately 80 km (50 mi) where it becomes part of Fault Zone F-9 (Oxley and others, 1968). It seems likely that the complex structure overlying Heidelberg Field also exists over Sand Hill Field.

The proximity of this fault zone to the Phillips Fault System suggests that the two may be related. However, a previous discussion referencing Morgan (1970) questions whether the Phillips Fault System does in fact involve faulting. The general lack of data about the Phillips Fault System makes a correlation between the two extremely tenuous and therefore speculative.

12.2.3.4.5.10 Fault Zone F-10: Overlying Glazier Dome and vicinity, seven distinct faults (F-10A through F-10G) have been interpreted to extend radially from the salt stock. These faults have been identified on the basis of structural contours, absence of stratigraphic sections in wells, and seismic evidence. The closest occurrence of F-10 to Lampton, Richton, and Cypress Creek domes is approximately 71, 5, 14 km (44, 3, and 9 mi), respectively.

On the top of the Lower Tuscaloosa (Figure 12-13), four faults, F-10A through F-10D, have been mapped. Each fault is approximately 1.6 km (1 mi) long and throws vary from 30 to 244 meters (100 to 800 ft). All faults except F-10D continue upward through the Selma Formation (Figure 12-14). In addition, Faults F-10E through F-10G first appear at the top of the Selma. Faults at the Selma vary in throw from approximately 24 to 76 meters (80 to 250 ft).

The proximity and radial orientation of these faults with respect to Glazier Dome suggest that they are related to domal growth. However, the existence of a closed structural depression over the domal area is apparent on Figures 12-15 through 12-20, suggesting that subsidence of the sediments overlying the dome occurred during the Tertiary. Such subsidence may result from dissolution of salt in Glazier Dome, or perhaps salt movement. Faulting has not been identified here above the Porters Creek Formation.

12.2.3.4.5.11 Faults Recognized from Seismic Data: In addition to those already discussed, numerous faults have been identified solely from purchased CDP seismic reflection data (Figures 12-25 through 12-30). Many faults are associated with diapiric movement of salt and subsidence resulting from salt withdrawal. Others may be the result of differential compaction of the sediments beneath thousands of feet of strata. There is no evidence of faulting younger than Eocene from any of the seismic data.

12.2.3.5 Salt Domes and Associated Structures: There are nine piercement salt domes in the Mississippi Study Area (Figure 12-12). Lampton, Tatum, Midway, McLaurin, Petal, Sunrise, Cypress Creek, and Richton Salt Domes are shallow-piercement types, whereas Glazier Dome is an intermediate-depth piercement feature. In the eastern portion of the study area, three salt domes are present on or near the crest of a structural ridge that trends perpendicular to the Wiggins Anticline. These are Petal, Sunrise, and McLaurin Domes (Eargle, 1968). Midway Dome is located between this structural ridge in the eastern part of the area and a structural trough in the northwestern portion of the study area.

All of these salt domes are characterized by the presence of distinct negative Bouguer anomalies on regional gravity surveys. Some domes have been explored by drilling in greater detail than others and, as a result, it is not possible to describe all domes in equal detail.

12.2.3.5.1 Lampton Salt Dome - Lampton Dome, one of the three candidate domes, is located in east-central Marion County, Mississippi (Figure 12-12). The shallowest caprock and salt penetrated by drilling was at depths of 398 and 502 meters (1,305 and 1,646 ft), respectively. A slight salt overhang exists around the middle portion of the salt stock, although the sides of the salt stock are almost vertical.

The sediments surrounding the dome dip steeply and are faulted. Diapiric clay was intruded along with the salt and may be part of a shale sheath. The Tatum Limestone member of the Catahoula Formation is the oldest sedimentary unit known to extend across the dome (Anderson and others, 1973). A detailed characterization of this dome is included in Section 13.2.

12.2.3.5.2 Tatum Salt Dome - Tatum Dome is located in southwestern Lamar County, Mississippi (Figure 12-12) and has been the subject of extensive research by the former United States Atomic Energy Commission (AEC) and the United States Geological Survey (Project Dribble (USGS-4339-2), an AEC study designed for scientific and defense purposes). The Salmon Event of Project Dribble measured the effects of a coupled nuclear explosion of 5-kiloton capacity (Anderson and others, 1973).

Information obtained from drilling and seismic surveys indicates that the top of salt is at depths between 445 and 488 meters (1,460 and 1,600 ft). The top of caprock is at depths between 261 and 293 meters (855 to 962 ft) (Anderson and others, 1973). The dome is roughly cylindrical to an elevation of 1,524 meters (5,000 ft) below sea level, and the surface of the salt stock is nearly flat. Faulting at Tatum Dome is discussed in Section 12.2.3.4.5.3.

The salt stock penetrates the base of the Miocene. Overlying the caprock are the Catahoula and Hattiesburg Formations. Pre-Miocene beds surrounding the dome are tilted and faulted, but no known faults affect beds on top of the dome (Anderson and others, 1973). Eargle (1968) noted "The Miocene beds covering the dome have been arched at least 152 meters (500 ft) since their deposition, and sand and gravel of the Citronelle Formation were arched and then removed from the crest of the dome by late Pleistocene and Recent erosion".

12.2.3.5.3 Midway Salt Dome - Midway Dome is located in central Lamar County, Mississippi (Figure 12-12). Only two wells have been drilled on the crest of the dome. Caprock and salt were penetrated at 405 and 672 meters (1,328 and 2,205 ft) below ground level, respectively (Halbouty, 1979). No information regarding the structure around the dome is available. However, despite lack of well control, Karges (1975) infers a simple graben on top of the dome.

Midway Dome is apparent on structure contour maps of the tops of the Lower Tuscaloosa, Selma, Porters Creek, Wilcox, Sparta, Cook Mountain, and Moodys Branch. It is manifested by domed strata with 457 meters (1,500 ft) of closure on the top of the Lower Tuscaloosa which decreases to less than 30 meters (100 ft) of closure on the top to the Moodys Branch (Figures 12-13 through

12-19). No faults have been interpreted in the vicinity of Midway Dome.

12.2.3.5.4 McLaurin Salt Dome - McLaurin Dome is located in central Forrest County, Mississippi (Figure 12-12). The shape of the dome is unknown due to insufficient geophysical and well data. However, structure contour maps on the top of the Lower Tuscaloosa, Selma, and Porters Creek indicate doming of strata surrounding McLaurin Dome (Figures 12-13 through 12-15).

Only two wells are located near the dome. Caprock and salt were penetrated at 520 and 588 meters (1,705 and 1,930 ft) below ground level, respectively. The top of the caprock is just below the Eocene Tallahatta Formation, and the lack of surface structural expression indicates that the dome probably has been stable since the Miocene (Anderson and others, 1973). No faults have been interpreted near the dome.

12.2.3.5.5 Petal Salt Dome - Petal Dome is located in north-central Forrest County, Mississippi (Figure 12-12). The shape and structure of the dome is unknown because of lack of geophysical and well data. However, depth to the top of caprock and salt has been reported as 376 and 503 meters (1,235 and 1,650 ft) below ground level, respectively (Halbouty, 1979; Eargle, 1968). Petal Dome is being used to store petroleum gases (Eargle, 1968). Faulting near Sunrise Dome, discussed in Section 12.2.3.4.5.5, trends toward Petal Dome; however, there is no evidence of faulting at the dome.

12.2.3.5.6 Sunrise Salt Dome - Sunrise Dome is located in northeastern Forrest County, Mississippi (Figure 12-12). It is a shallow-piercement salt dome with caprock and salt at depths of 1,710 and 1,811 meters (5,610 and 5,940 ft) below ground level, respectively (Halbouty, 1979).

The dome is apparent on structure contour maps of the tops of the Lower Tuscaloosa, Selma, and Porters Creek (Figures 12-13 through 12-15). On the top of the Lower Tuscaloosa, the southwestern segment of the dome has about 396 meters (1,300 ft) of closure, part of which is created by a large normal fault with displacement to the northeast (Figure 12-13). This faulted uplift is apparent on all contoured horizons below the Wilcox Group. The amount of throw on the major fault decreases upward (Figures 12-13, 12-14 and 12-15). Faulting near Sunrise Dome is discussed in Section 12.2.3.4.5.5.

12.2.3.5.7 Cypress Creek Salt Dome - Cypress Creek Dome, one of the three candidate domes, is located in south-central Perry County, Mississippi (Figure 12-12). The shallowest caprock and salt were encountered at depths of 357 and 419 meters (1,172 and 1,376 ft), respectively.

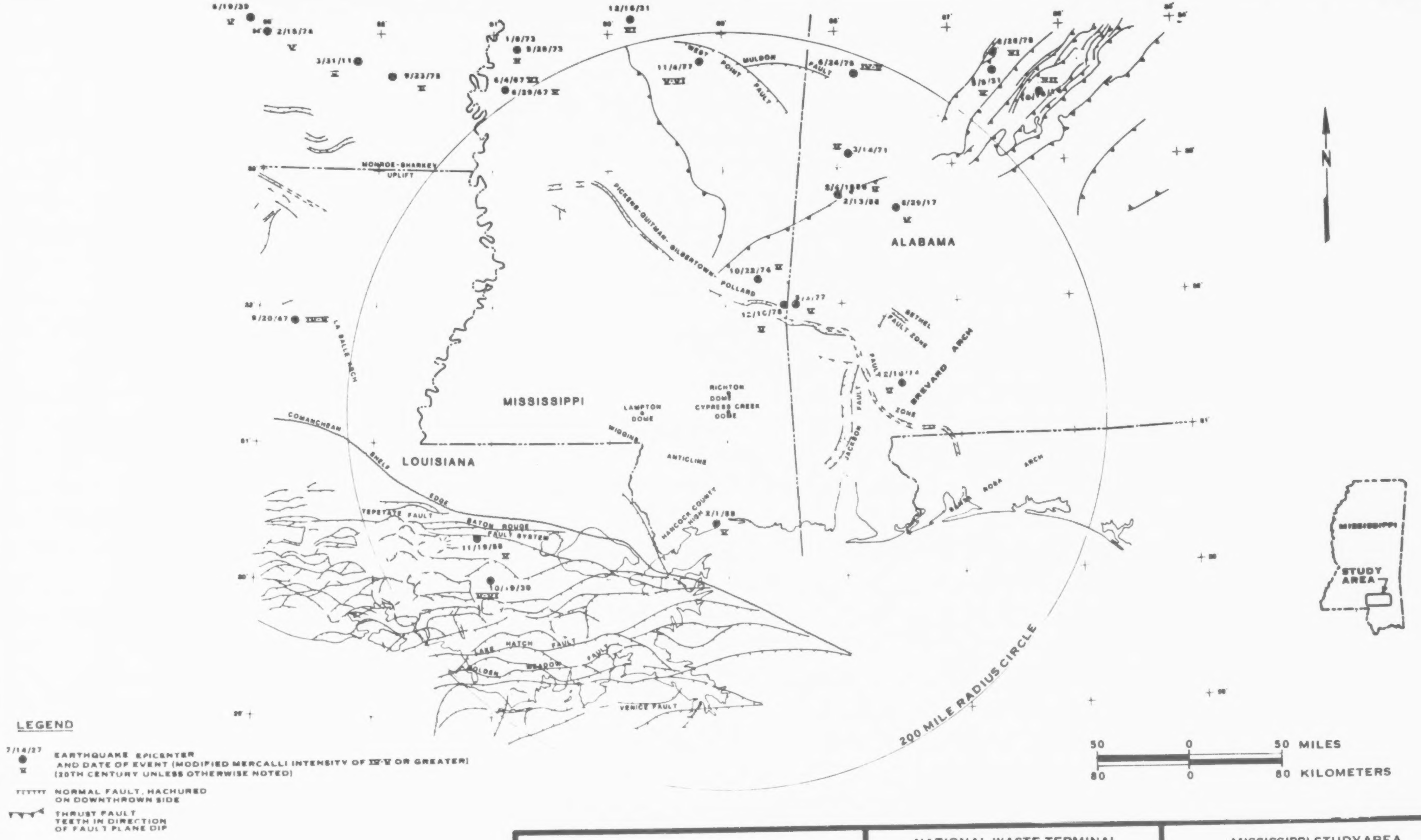
Gravity data indicate that the salt stock is a lopsided, mushroom-shaped pillar with an elliptical, northwesterly oriented base with an overhang around the entire dome. The youngest formation penetrated by the salt is the Miocene Hattiesburg Formation. Faulting has been identified on the southeastern flank of the dome (Section 12.2.3.4.5.8). A detailed characterization of this dome is included in Section 13.1.

12.2.3.5.8 Richton Salt Dome - Richton Salt Dome, one of the three candidate domes, is located in northern Perry County, Mississippi (Figure 12-12). The salt covers some 18 km^2 (7 mi^2 at 610 meters (2,000 ft) below sea level, making it the largest piercement dome in the Mississippi Salt Basin. It is also the shallowest salt dome in Mississippi with the shallowest caprock and salt at depths of 151 and 220 meters (497 and 722 ft), respectively (Karges, 1975). Thirty unsuccessful sulfur test wells have been drilled into the caprock, eight of which penetrated salt. Karges (1975) used data from these wells and unsuccessful petroleum test wells on the dome flanks to contour the configuration of the dome.

Recent drilling demonstrates that Richton Dome intrudes sediments as young as the Catahoula Formation and possibly the Hattiesburg Formation. One fault, discussed previously in Section 12.2.3.4.5.7, has been identified on the northwestern flank of the dome. Rim syncline development to the northeast of the dome is apparent in Figures 12-13 through 12-20. A detailed characterization of this dome is included in Section 13.3.

12.2.3.5.9 Glazier Salt Dome - Glazier Dome is located in east-central Perry County, Mississippi (Figure 12-12). It is an intermediate-depth dome with caprock and salt at depths of 2,279 and 2,342 meters (7,476 and 7,685 ft), respectively (Halbouty, 1979). Domal movement has caused faulting on its flanks (Karges, 1975), and the dome penetrates to the base of the Upper Tuscaloosa Formation. Glazier Dome is apparent on the structure contour map of the Lower Tuscaloosa Formation (Figure 12-13). It is radially faulted on its flanks by faults which are mappable on the top of the Lower Tuscaloosa, discusssed previously in Section 12.2.3.4.5.10. These faults continue upward through the Selma and Porters Creek Formations. Above these formations, faulting is no longer evident. However, a closed depression overlying the dome is apparent from structure contour maps from the Porters Creek up through and including the Vicksburg (Figures 12-15 through 12-20). This may indicate domal movement, probably caused by deep salt withdrawal as recently as Oligocene time.

12.2.4 SEISMICITY: The Mississippi Study Area was evaluated to determine its seismic risk. The historic earthquakes of a portion of the Gulf Coastal Province were compiled, evaluated, and then compared with tectonic structures and nontectonic sources in the region to determine if any correlations exist (Figure 12-31). Since no positive tectonic correlations were found, the concept of seismotectonic regions (See Volume I, Sec. 2.5.1) was used to analyze seismic risk at the candidate domes. The seismic risk analysis identifies the maximum-credible earthquake, return period, and the probability of earthquake occurrence.


MISSISSIPPI
LOUISIANA
ALABAMA
N
200 MILE RADIUS CIRCLE
MONROE-SHARKEY UPLIFT
LA SALLE ARCH
COMANCHEAN SHELF EDGE
PICKENS-QUITMAN-GILBERTOWN-POLLARD
WEST POINT FAULT
MULDON FAULT
BETHEL FAULT ZONE
BREVARD ARCH
JACKSON FAULT
FAULT ZONE
ROBA ARCH
LAMPTON DOME
RICHTON DOME
CYPRESS CREEK DOME
WIGGINS ANTICLINE
HANCOCK COUNTY HIGH
TEPETATE FAULT
BATON ROUGE FAULT SYSTEM
LAKE HATCH FAULT
GOLDEN MEADOW FAULT
VENICE FAULT
6/19/30
2/15/74
3/31/11
9/23/78
1/8/73
8/28/73
6/4/67
6/29/67
12/16/31
11/4/77
6/24/75
3/14/71
2/13/86
6/29/17
10/22/76
12/16/78
9/20/47
11/19/58
10/19/30
2/1/55
MISSISSIPPI
STUDY AREA
50
0
50 MILES
80
0
80 KILOMETERS
LEGEND
7/14/27
EARTHQUAKE EPICENTER AND DATE OF EVENT (MODIFIED MERCALLI INTENSITY OF IV-V OR GREATER) (20TH CENTURY UNLESS OTHERWISE NOTED)
NORMAL FAULT, HACHURED ON DOWNTHROWN SIDE
THRUST FAULT TEETH IN DIRECTION OF FAULT PLANE DIP

COMPILED FROM GCAGS & AAPG, TECTONIC MAP OF GULF COAST REGION USA (1972), U.S. EARTHQUAKES (1928-77), EARTHQUAKE HISTORY OF THE U.S. (1973), NOAA (1979), LAW ENGINEERING (1980), DOCEKAL (1970).

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED ______ DATE ______
APPROVED [illegible] DATE [illegible]
T-1258-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
REGIONAL EPICENTER LOCATION MAP
JOB NO MV 9600
FIGURE 12-31

BEST DOCUMENT AVAILABLE

12.2.4.1 Historic Seismicity: The Mississippi Salt Basin is located in a region of low seismic activity. Figure 12-31 illustrates the locations of the historic earthquakes which have occurred within the area studied. Tables G-1.1 (Mississippi Study Area Appendix) and 2.5-1 (Volume I) elaborate on the details of each earthquake.

There have been 15 historic earthquakes greater than intensity IV MM (Modified Mercalli Intensity Scale) within the region of study. These historic events include one IV-V MM, eight V MM, one V-VI MM, and five VI MM intensity earthquakes.

12.2.4.2 Regional Tectonics and Seismicity: Regional tectonism and seismicity, discussed in Chapter 2, (Volume I) presents the basic tectonic concepts and evaluation of the Gulf Coastal Province and its present state of seismicity. This evaluation of the regional seismicity enhances our understanding of local historic earthquakes and their association with tectonic structures that extend into the study area.

12.2.4.3 Correlation of Epicenters: An attempt was made to correlate reported earthquakes with faults, fault zones, other geologic structures, storms, reservoirs, explosions, and oil and gas field activity. Possible correlations established with several oil and gas fields are discussed below.

The known major geologic structures in and around the Mississippi Salt Basin (Figure 12-5) are discussed in Chapter 2 (Volume I). None of the faults are known to be capable of generating "felt" earthquakes (>IV MM). Figure 12-31 illustrates that earthquakes have occurred in the region. The earthquakes are probably generated by deep basement faults which have not been mapped, or by shallow nontectonic faults. The injection and withdrawal of fluids in the subsurface has been demonstrated to induce earthquakes (Lee, 1978). The production of oil and gas involves the injection and extraction of fluids (oil, gas, water) to enhance recovery during declining production. The extraction of fluids and suspended solids will cause subsidence (Sellards, 1930) and the consequent reorientation of subsurface stresses. The injection of fluids causes increased hydrostatic pressure, resulting in decreased values of cohesion along existing fault planes and local uplift. Both injection and extraction may trigger local earthquakes. Therefore, locally felt earthquakes (felt area less than 1,000 km^2 (386 mi^2) in the area studied were evaluated to determine if correlations existed within oil and gas fields.

12.2.4.3.1 Epicenter Correlation within Oil and Gas Fields - Oil and gas production began in the Mississippi Salt Basin about 1939. Locally felt earthquakes during the post-1939 period were selected from Mississippi Study Area Appendix Table G-1.1 for evaluation of seismic activity possibly related to oil and gas production. The following events were selected as suspect.

Huxford, Alabama, December 10, 1974 - This event was reported in U.S. Earthquakes (1974) and in Preliminary Determination of Epicenters (1974), as intensity V MM at Huxford, where small objects fell from shelves. It was a shallow focus event, estimated by the USGS to be at a depth of 10 km (6.2 mi), with a magnitude calculated to be 3.0. The epicentral location (Mississippi Study Area Appendix Table G-1.1) is 3 km (1.86 mi), northeast of the Uriah Field, which began production in 1970; 6.5 km (4 mi) north of the Vocation Field, which opened in 1971; and 14.5 km (9 mi) northwest of the Barnett Field, which started production in 1973. The Huxford earthquake may have been induced or triggered by operations in any of these oil and gas fields.

Melvin, Alabama, December 19, 1978 - This earthquake epicenter was located in Mississippi, 10.5 km (6.5 mi) northwest of Melvin, and reported in Preliminary Determination of Epicenters (1978) to have been an Intensity V MM earthquake near Melvin with a magnitude of 3.5. It was a shallow focus event. The epicentral location (Mississippi Study Area Appendix Table G-1.1) is 5 km (3 mi) northwest of an unnamed oil and gas field which started production in 1977; 6.5 km (4 mi) north of the Double Creek Field, which began production in 1968 and is now abandoned; 8 km (5 mi) northeast of the Junction City Field, which was opened in 1958; and 9.5 km (6 mi) northwest from the Okatuppa Creek Field, which began production in 1969. The event was on the southwestern tip of a northwesterly trending normal fault, which has recorded 100 meters (328 ft) of displacement. The epicenter is 3 km (1.86 mi) north of the Pickens-Quitman-Gilbertown-Pollard Fault Zone. The Melvin earthquake may have been induced or triggered by operations in any of these oil and gas fields.

The type exposure of the Melvin Fault is near the town of Melvin, Alabama. Along this system, the Gilbertown-Langsdale Oil Fields have been producing large volumes of oil and gas from fractured chalk and from closure on underlying Eutaw sands at shallow depths. Production in this area began in 1944.

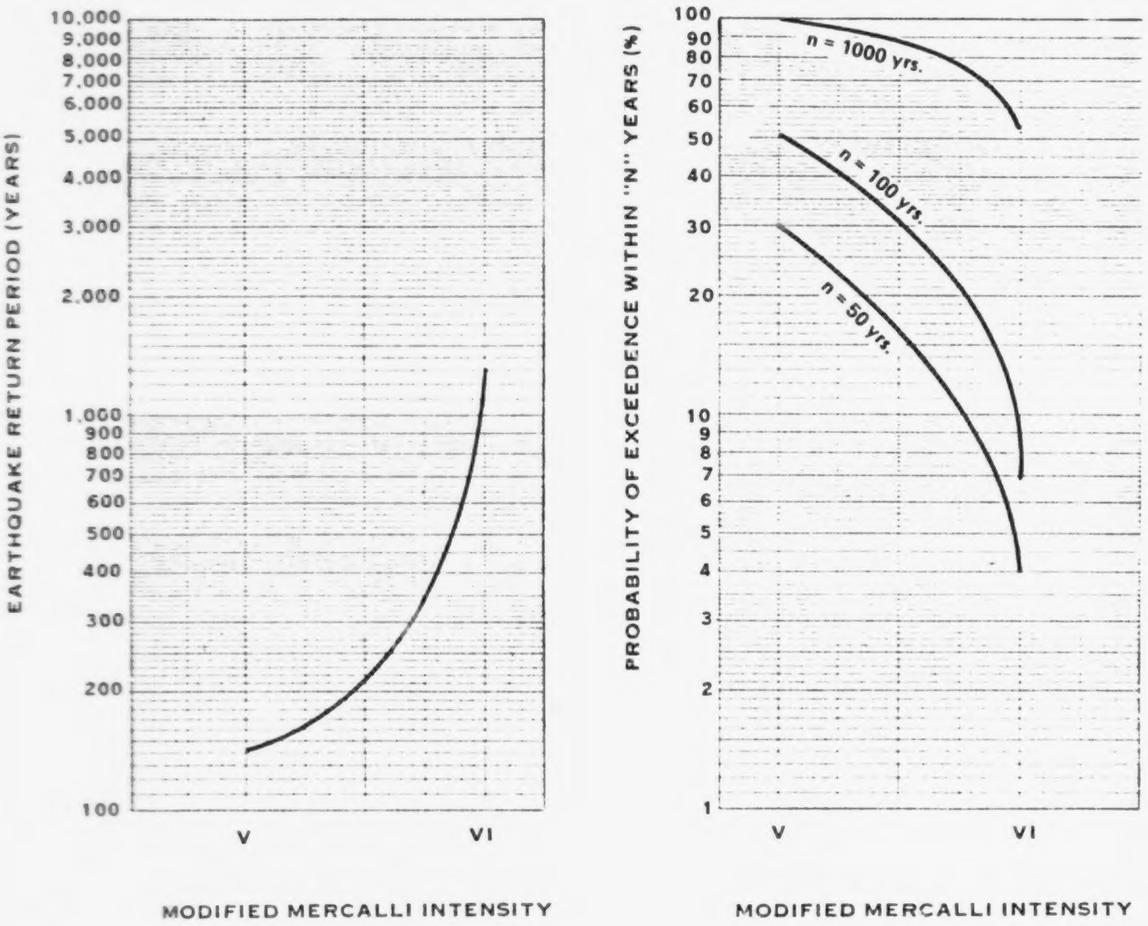
12.2.4.4 Seismic Risk Analysis: No positive correlations could be made between geologic structures and documented historic earthquakes in this region; accordingly, analysis based on seismotectonic regions was used to establish seismic risk. Seismotectonic regions are areas of similar tectonic history and seismic activity. Figure 2-14 (Volume I) shows the location of the Mississippi Salt Basin in the Interior Salt Basins Seismotectonic Region.

The Interior Salt Basin Seismotectonic Region has a maximum historic earthquake of intensity VI MM. The analyses assumed that an event of this intensity could have been generated anywhere within the region or attenuated from the neighboring seismotectonic regions.

A return period and probability of exceedence calculation was made for the candidate domes in the Mississippi Salt Basin. Figure 12-32 describes the results of this analysis. Reference is made to Volume I, Section 2.5 for a complete description of this analysis technique.

In summary, the seismic activity for the study area is low. The candidate salt domes in the Mississippi Salt Basin Study Area can expect a maximum ground-motion surface intensity of VI MM.

AF 12338A



PREPARED JDG DATE 5-30-80
REVISED OGP DATE 12/4/81
REVISED ______ DATE ______
APPROVED ______ DATE 8/20/80
T-1259-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
EARTHQUAKE RETURN PERIOD
AND PROBABILITY OF
EXCEEDENCE CURVES

JOB NO. MV9600 FIGURE 12-32

[redacted]

BEST DOCUMENT AVAILABLE

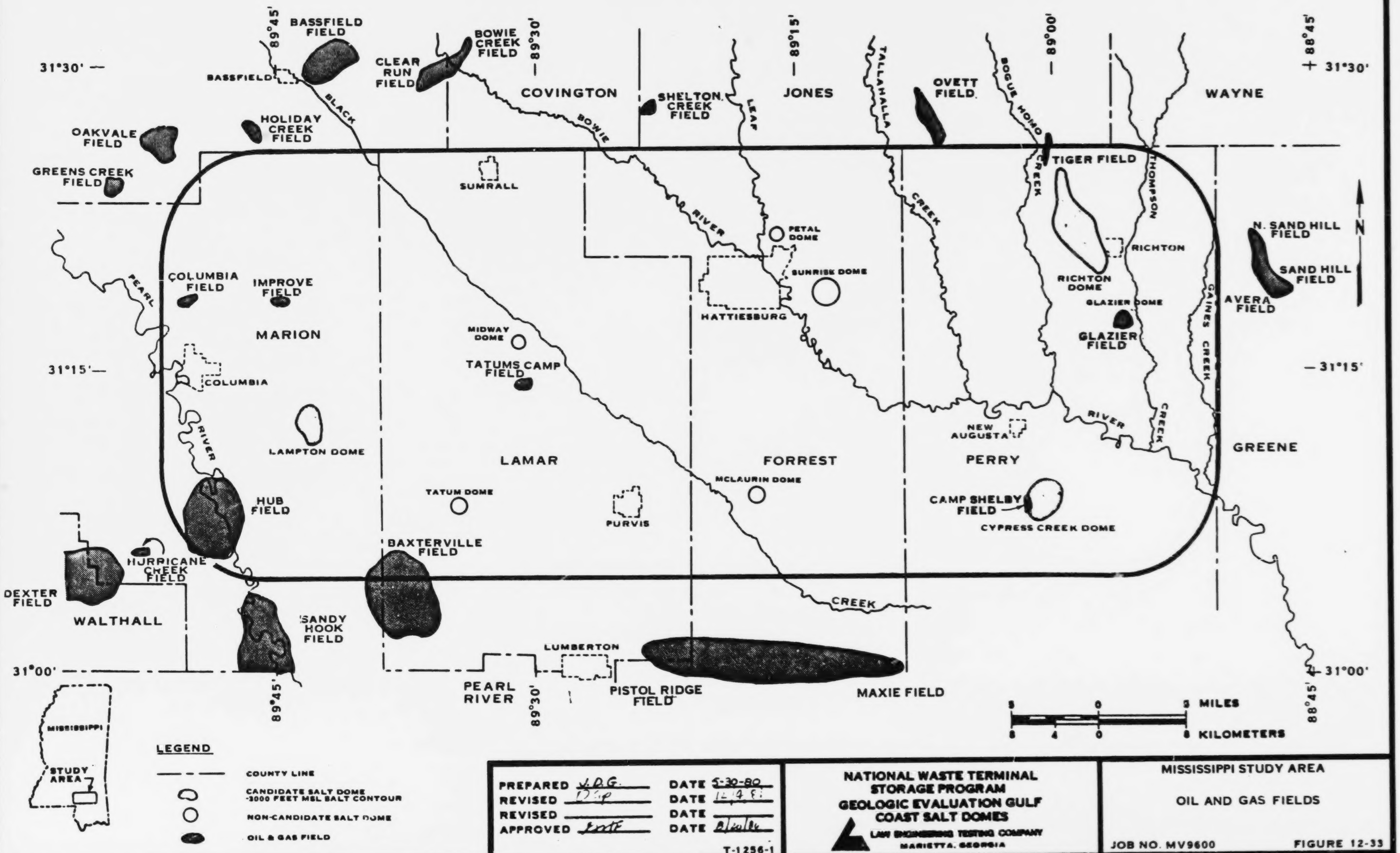
No tectonic features capable of generating earthquakes were identified within the study area.

12.3 MINERAL RESOURCES OF THE MISSISSIPPI STUDY AREA

Three types of mineral commodities are of potential economic significance within the Mississippi Study Area. From highest to lowest potential these are: hydrocarbons, mineral aggregates, and lignite. In this report, the term hydrocarbon includes crude oil, condensate, dry gas and casinghead gas. The term mineral aggregates includes sand, gravel, and clay. Lignite means low-grade carbonaceous deposits which contain up to 50 percent water, 36 to 47 percent volatile matter, 25 to 42 percent fixed carbon, 6 to 25 percent ash, and yield 7,200 to 10,000 BTU/pound (Mellen, 1959).

12.3.1 HYDROCARBON RESOURCES: The Mississippi State Oil and Gas Board listed eight producing oil and gas fields within the Mississippi Study Area in September, 1979. The fields are Hub, Baxterville, Columbia, Improve, Tatums Camp, Camp Shelby, Glazier, and Tiger (Figure 12-33). Production is from reservoirs ranging in age from early Cretaceous through early Tertiary. The total cumulative production through 1979, as well as annual production figures for 1979, the latest year for which annual figures are available, are contained in Table 12-4.

Crude oil and natural gas production on a statewide basis has shown a steady decline from mid-1970 to 1979 for oil, and from mid-1967 to 1976 for natural gas, with a minor upswing in natural gas production in 1977 and 1978 (Figure 12-34) (Mississippi State


31°30'
89°45'
BASSFIELD FIELD
BASSFIELD
BLACK
CLEAR RUN FIELD
BOWIE CREEK FIELD
89°30'
COVINGTON
BOWIE
SHELTON CREEK FIELD
LEAF
89°15'
JONES
TALLAHALLA
OVETT FIELD
BOGUE HOMO
89°00'
WAYNE
88°45'
OAKVALE FIELD
HOLIDAY CREEK FIELD
GREENS CREEK FIELD
SUMRALL
TIGER FIELD
CREEK
THOMPSON
RIVER
PETAL DOME
N. SAND HILL FIELD
N
RICHTON
SUNRISE DOME
SAND HILL FIELD
PEARL
COLUMBIA FIELD
IMPROVE FIELD
HATTIESBURG
RICHTON DOME
GLAZIER DOME
AVERA FIELD
GAINES CREEK
MARION
MIDWAY DOME
GLAZIER FIELD
31°15'
TATUMS CAMP FIELD
COLUMBIA
RIVER
NEW AUGUSTA
LAMPTON DOME
LAMAR
FORREST
PERRY
GREENE
MCLAURIN DOME
TATUM DOME
HUB FIELD
CAMP SHELBY FIELD
PURVIS
CYPRESS CREEK DOME
BAXTERVILLE FIELD
HURRICANE CREEK FIELD
DEXTER FIELD
CREEK
WALTHALL
SANDY HOOK FIELD
LUMBERTON
31°00'
PEARL RIVER
PISTOL RIDGE FIELD
MAXIE FIELD
5 0 5 MILES
8 4 0 8 KILOMETERS
MISSISSIPPI
STUDY AREA
LEGEND
COUNTY LINE
CANDIDATE SALT DOME -3000 FEET MSL SALT CONTOUR
NON-CANDIDATE SALT DOME
OIL & GAS FIELD

PREPARED J.D.G. DATE 5-30-80
REVISED DSP DATE 12-4-81
REVISED DATE
APPROVED DATE

T-1256-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

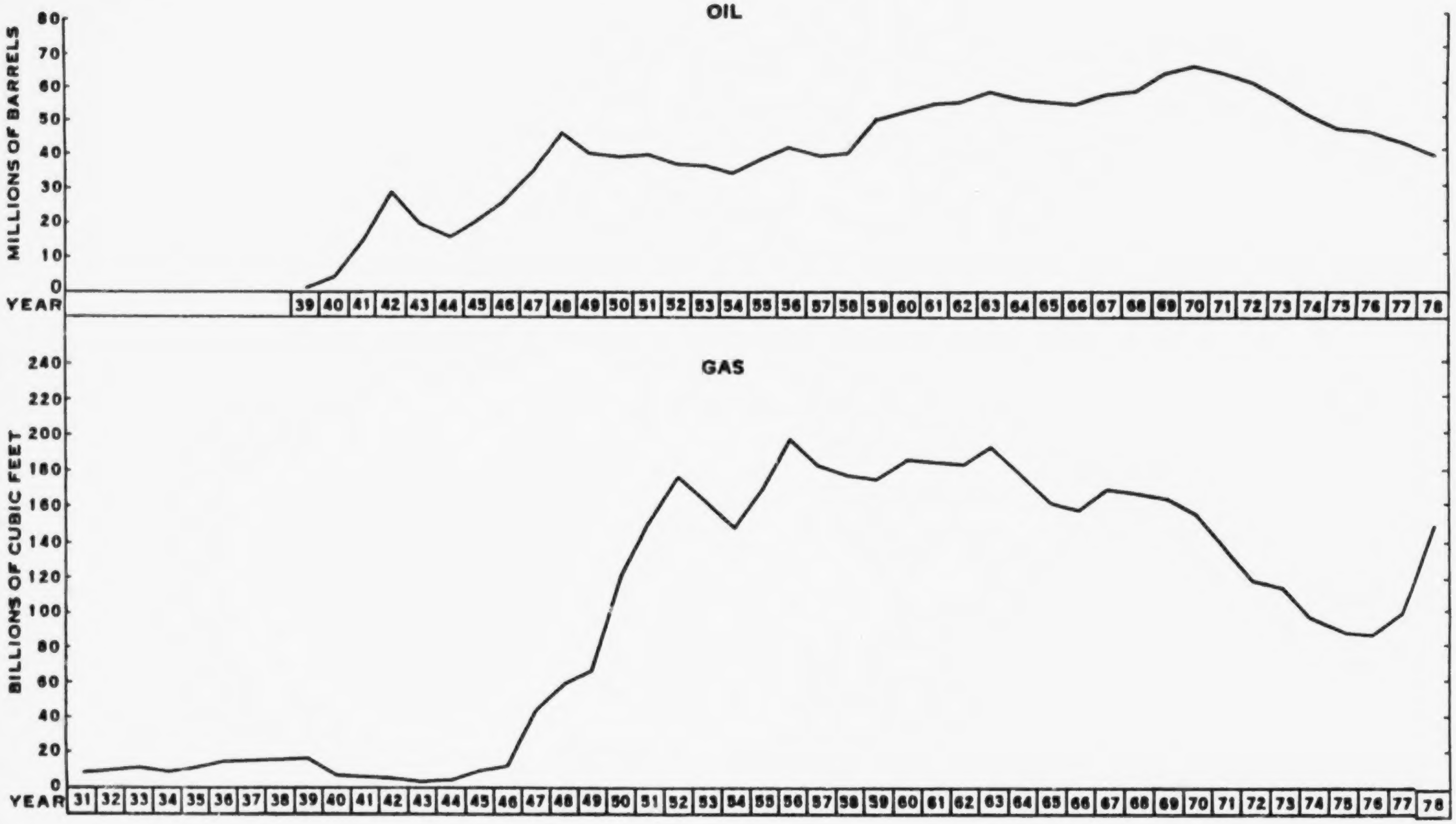
MISSISSIPPI STUDY AREA

OIL AND GAS FIELDS

JOB NO. MV9600 FIGURE 12-33

BEST DOCUMENT AVAILABLE

AF 12338 B



DATA FROM MISSISSIPPI OIL & GAS BOARD, 1980.

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE 12/4/81
REVISED DATE
APPROVED [illegible] DATE [illegible]
T-1257-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
MISSISSIPPI OIL AND GAS PRODUCTION

JOB NO. MV9600
FIGURE 12-34

FIGURE 12-34

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 12-4

HYDROCARBON PRODUCTION FOR MISSISSIPPI STUDY AREA

FIELD NAME	NO. OF PRODUCING WELLS	1979 PRODUCTION OIL (BBL)	1979 PRODUCTION GAS (MCF*)	CUMULATIVE PRODUCTION THROUGH 1979 OIL (BBL)	CUMULATIVE PRODUCTION THROUGH 1979 GAS (MCF)
BAXTERVILLE	277	5,517,390	3,066,823	196,530,798	411,054,190
CAMP SHELBY	3	25,496	29,374	219,228	151,758
COLUMBIA	1	0	0	479	22,493
GLAZIER	2	12,120	0	628,584	2,944
HUB	33	61,772	4,528,613	824,987	319,408,981
IMPROVE	1	141	16,437	141	16,437
TATUMS CAMP	2	59,002	849,492	59,863	849,492
TIGER	4	118,365	441,425	231,107	818,019
	TOTAL	5,794,145	8,915,727	205,895,187	732,363,903

---

* MCF - 1000 cubic feet

Oil and Gas Board, 1980). Improvement in exploration technology and deeper drilling techniques are expected to make deeper targets such as the Lower Cretaceous Hosston Formation increasingly important to hydrocarbon production in Mississippi.

Petroleum accumulations within the study area are predominantly controlled by structural closures caused by salt movement. Two of the eight fields, Camp Shelby and Glazier Fields, are associated with piercement salt domes, and the rest are related to deep-seated salt movement. Production from Camp Shelby Field is small (Mellen, 1979), and production from the Glazier Field production is less than that at Camp Shelby. From a historical and comparative basis, it seems unlikely that the domes within the study area will yield any significant amounts of hydrocarbons.

12.3.1.1 Hub Field: Hub Field, an oil and gas field, is located in southern Marion County approximately 8 km (5 mi) southwest of Lampton Dome. The structural trap is an elongate, doubly plunging anticline formed by deep-seated salt movement. Faults related to this movement form a central graben over the fold (Knight, 1951; Arledge, 1957). A detailed discussion of the structure underlying Hub Field may be found in Section 12.2.3.4.3.

The discovery well for Hub Field was completed on February 25, 1945 (Frascogna, 1957). Production is from sandstones and limestones of the Lower Cretaceous Mooringsport, Paluxy, Washita-Fredericksburg, and Dantzler Formations. The Mooringsport and of Paluxy Formations consist of marginal marine, and deltaic fine- to coarse-grain silty sands, clays, and pseudo-oolitic to nodular limestones. The fine to medium-grain sands and mudstones of the Washita-Fredericksburg Formations are locally calcareous in southern Mississippi and they are transitional to the overlying limestones of the Dantzler Formation. Production in the Dantzler Formation is from a fine to medium-grain, calcareous silty, micaceous sandstone (Nunnally and Fowler, 1954).

There is also some production from the sandstones of the Lower Tuscaloosa and Eutaw Formations. The deltaic Lower Tuscaloosa has yielded production from a basal massive sandstone unit which unconformably overlies the Dantzler Formation. Additional production within the Upper Cretaceous comes from the deltaic interbedded sandstones and claystones of the Eutaw Group (Rainwater, 1963; Mississippi Oil and Gas Board, 1978).

12.3.1.2 Baxterville Field: Baxterville Field is an oil and gas field approximately 12 km (7.5 mi) southeast of Lampton Dome in southwestern Lamar and southeastern Marion Counties. The oil and gas is trapped in a large, complexly faulted, elongated anticline, and accumulation is attributed to anticlinal closure rather than to fault closure (Davis and Lambert, 1963). A detailed discussion of the structure at Baxterville Field may be found in Section 12.2.3.4.4.

The discovery well in Baxterville Field was completed on November 18, 1944 (Frascogna, 1957). The deepest production is from the deltaic facies of the Hosston Formation, which consists of shales, silts, and fine-grain sandstones, and which is the only Lower Cretaceous producing zone in the field. Other producing zones include the Upper Cretaceous Lower and Upper Tuscaloosa Formations, the Eutaw and Selma Groups, and the Wilcox Group. The Upper and Lower Tuscaloosa Formations are deltaic deposits consisting of interbedded shales, mudstones, and sandstones. The Eutaw Group also consists of interbedded deltaic sandstones and claystones. Some production is from the marine chalks of the Selma Group (Rainwater, 1963) and apparently deltaic channel sands of the Wilcox Group (Craft, 1966).

12.3.1.3 Columbia Field: Columbia Field is an oil and gas field in north-central Marion County, approximately 14 km (8.5 mi) northwest of Lampton Dome. The structure of the Columbia Field is an anticline, and production is from the Lower Cretaceous Hosston Formation (Mississippi State Oil and Gas Board, 1978). The discovery well, which is the only completed well to date in the field, was completed on May 26, 1977.

12.3.1.4 Improve Field: Improve Field is an oil and gas field located in north-central Marion County, approximately 10 km (6 mi) north of Lampton Dome. Improve Field produces from the Lower Cretaceous Hosston Formation. The structural trap is formed by structural closure over a residual salt anticline (Mellen, 1980). The discovery well, and only well to date, for Improve Field was completed on August 10, 1978 and produced during September, 1978, but has yielded no production since.

12.3.1.5 Tatums Camp Field: Tatums Camp Field is an oil field in central Lamar County, approximately 18 km (11 mi) east of

Lampton Dome. Tatums Camp Field produces from an anticlinal trap in the Hosston Formation similar to that of Columbia Field (Mississippi State Oil and Gas Board, 1978). The discovery well for this field was completed on October 8, 1972. A second productive well was completed on October 2, 1979 (Mississippi State Oil and Gas Board, 1979).

12.3.1.6 Camp Shelby Field: Camp Shelby Field is an oil and gas field located beneath the overhang of Cypress Creek Dome in southern Perry County. Cypress Creek is one of the three candidate domes in Mississippi. Production is obtained from strata of the Paluxy Formation and from biohermal masses in the Clayton Formation. Petroleum accumulations presumably result from structural closure of beds against the salt stock and their truncation by the salt. The discovery well for this field was completed on June 27, 1972.

12.3.1.7 Glazier Field: Glazier Field, an oil and gas field in east-central Perry County, is approximately 4 km (2.5 mi) southeast of Richton Dome. Producing zones include the Lower and Upper Tuscaloosa Formations on the flanks of this intermediate-depth, highly faulted, piercement salt dome (Mississippi State Oil and Gas Board, 1979). Petroleum accumulation may result from structural closure caused by domal movement, or by fault traps also related to domal movement. The discovery well for Glazier Field was completed on December 18, 1951.

12.3.1.8 Tiger Field: Tiger Field is an oil and gas field in north-central Perry County, approximately 4 km (2.5 mi) northwest of Richton Dome. The controlling structure is presumably a deep salt anticline. The discovery well for this field was completed on February 23, 1971 (Mississippi State Oil and Gas Board, 1978).

12.3.2 MINERAL AGGREGATES: Sand and gravel are produced throughout the Mississippi Study Area, and Bicker (1970) ranks the four counties of the Mississippi Study Area in decreasing order of sand and gravel production volume as follows: Forrest, Perry, Marion, and Lamar. Sand and gravel are produced from what have been previously termed terraces (Foster and McCutcheon, 1941), the Citronelle gravel belt (Mellen, 1959), and upland graveliferous deposits (Bowen, 1978), as well as from Recent alluvium. The depositional environments in which these deposits formed were predominantly fluvial to deltaic during late Tertiary and Quaternary time (Eargle, 1968). These deposits consist of fine to coarse quartz sands and clayey sands with chert and quartz gravels and occasional interbedded clays. Reliable estimates of aggregate reserves are not available because much of the data is proprietary. Nevertheless, aggregates are a major commodity within the Mississippi Study Area; they have a stable production history as well as a good outlook for use as roadway ballast and for construction use.

Miocene clays of the shallow marine Pascagoula Formation and the estuarine and intradeltaic Hattiesburg Formation, which are exposed in the study area, have been used in brick production at

Hattiesburg since 1901 (Logan, 1908). The Hattiesburg Brick Works is today a major supplier of construction brick and tile for its trade area, and no radical change in production volume and distribution is expected. The production of mineral aggregates would exert little or no influence on the underlying salt structures.

12.3.3 LIGNITE: Lignite occurs throughout the Mississippi Study Area as isolated lenses of lignitic clays within the Catahoula and Pascagoula-Hattiesburg Formations. These lenses are apparently the result of deposition of highly organic clays in marginal deltaic, fluvial, and swamp environments (Eargle, 1968; May, 1974). Other lignitic formations occur in the Cockfield, Wilcox, and Porters Creek Formations. Approximately 97 to 161 km (60 to 100 mi) north of the study area, production has been considered from lignite beds 2 to 2.5 meters (7 to 8 ft) thick, possibly in the Claiborne or Wilcox Groups, beneath approximately 30 meters (100 ft) of overburden (Bicker, 1977.) The stratigraphic equivalent to these beds in the study area is approximately 305 to 1,158 meters) (1,000 to 3,800 ft) below the ground surface, making potential development of these deposits with present technology speculative at best.

12.4 SUMMARY OF THE MISSISSIPPI STUDY AREA

The Mississippi Study Area is in the southeastern portion of the Mississippi Salt Basin. There are nine piercement salt domes in the study area, including the three candidate domes, Cypress

Creek, Lampton, and Richton. In addition, several deep-seated salt swells have been identified in the study area. Although the geologic characterization studies focused on the candidate domes and surrounding areas, the relevant relationships and influences of the major geologic elements of the much larger Mississippi Salt Basin are reviewed and evaluated.

Preexisting data consisting of oil, gas, and water-well logs, seismic reflection surveys, regional residual gravity anomaly maps, and geologic maps were purchased and evaluated. Data acquired specifically for this study consisted of deep and shallow borings, high-resolution seismic reflection surveys, ground-level resistivity surveys, field geologic mapping, remote sensing, and detailed gravity surveys and models. Geologic cross sections, structural contour maps, and isopach maps have been developed. These data represent the basis from which the geologic history and present geologic conditions of the study area have been interpreted.

The regional structure and lithology of the stratigraphic units control the physiography of the study area. Several structurally negative areas or subbasins within the study area have been identified and interpreted as localized centers of deposition within the Mississippi Salt Basin. Movement of the Louann Salt away from these basinal areas into linear salt ridges and diapiric salt domes caused the subsidence and thickening of strata in these subbasins. The Perry Basin is an example of a large subbasin that was active from Paleocene-Eocene time through at least the Oligocene.

[redacted]

Faulting has been identified within the study area. Most of the faulting can generally be characterized as minor, having been associated with salt movement. Several faults with displacements in excess of 213 meters (700 ft) have been interpreted on or near the flanks of all candidate domes. Some of these faults displace strata as old as Jurassic and as young as Eocene. One fault over Richton Dome has been identified in Miocene beds. There is no evidence of post-Quaternary faulting. Published literature describes major, regional faulting in the extreme northeastern corner of the study area. There is some question whether this faulting, referred to as the Phillips Fault System, in fact represents regional faulting.

Seismicity studies within the Mississippi Salt Basin indicate that the seismic activity for the study area is low. The candidate salt domes can expect a maximum ground-surface motion of intensity VI MM (Modified Mercalli). No tectonic features capable of generating earthquakes were identified within the study area.

The major mineral resources of the study area are petroleum, natural gas, and mineral aggregates. Exploration and production of these resources are expected to continue with gas and oil production steady or increasing slightly.

12.5 LIST OF REFERENCES CITED

Anderson, R.E., Eargle, D.H., and Davis, B.O., 1973, Geologic and hydrologic summary of salt domes in Gulf Coast region of Texas, Mississippi, and Alabama: U.S. Geological Survey, Open-File Report USGS-4339-2, 294 p.

Applin, P.L. and Applin, E.R., 1953, The cored section in George Vassen's Fee Well I, Stone County, Mississippi: Washington, D.C., U. S. Geological Survey Circular 298, 29 p.

Arledge, E.A., 1957, The geology the Hub oil field, Marion County, Mississippi: Masters thesis, Mississippi State College, 49 p.

Badon, C.L., 1975, Stratigraphy and petrology of Jurassic Norphlet formation, Clarke County, Mississippi: American Association of Petroleum Geologists Bulletin, v. 59, pp. 377-392.

Bicker, A.R., Jr., 1966, Claiborne County geology, in Bicker, A.R., Jr., and others, Claiborne County geology and mineral resources: Mississippi Geological Survey, Bulletin 107, pp 9-93.

Bicker, A.R., Jr., 1970, Economic minerals of Mississippi: Mississippi Geological Survey, Bulletin 112, 80 p.

Bicker, A.R., Jr., 1977, Telephone conversation with Law Engineering Testing Company representative, November 11, 1977.

Bowen, R.L., 1978, Neogene geology of the Hattiesburg district, Mississippi: Upland graveliferous deposits: Geological Society of America Bulletin, Abstracts with programs, v. 10, no. 4, p. 163.

Childress, S.C., 1973, Mississippi geologic names: Mississippi Geological Survey, Bulletin 118, 172 p.

Craft, W.E., 1966, Channel sands are the key to Wilcox oil: Oil and Gas Journal, v. 64. no. 15, pp. 124-130.

Davis, D.C., and Lambert, E.H., ed., 1963, Mesozoic-Paleozoic producing areas of Mississippi and Alabama, v. 2: Mississippi Geological Society, 156 p.

Dinkins, T.H., Jr., 1966, Subsurface stratigraphy of Claiborne County, in Bicker, A.R., Jr., and others, Claiborne County geology and mineral resources: Mississippi Geological Survey, Bulletin 107, pp. 95-117.

[redacted]

Dinkins, T.H., Jr., 1967, Subsurface stratigraphy of George County, in Williams, C.H., Jr., and others, George County Geology and Mineral resources: Mississippi Geological Survey, Bulletin 108, pp 191-227.

Dinkins, T.H., Jr., 1968, Jurassic stratigraphy of central and southern Mississippi, in Dinkins, T.H., Jr., and others, Jurassic stratigraphy of Mississippi: Mississippi Geological Survey, Bulletin 109, pp. 9-37.

Docekal, J., 1970, Earthquakes of the stable interior: Ph.D. Thesis, University of Nebraska.

Eargle, D.H., 1964, Surface and subsurface stratigraphic sequence in southeastern Mississippi: U.S. Geological Survey Professional Paper 475-D, article 130, pp. D43-D48.

Eargle, D.H., 1968, Stratigraphy and structure of the Tatum Salt Dome area, southeastern Mississippi and northeastern Washington Parish, Louisiana: Geological Society of America, Special Paper 88, pp. 382-405.

Earthquake history of the U.S. 1973, 1975, National Oceanic and Atmospheric Administration, Silver Springs, Maryland.

Fenneman, N.M., 1938, Physiography of eastern United States: McGraw-Hill Book Company, New York, 714 p.

Fisk, H.N., 1944, Geological investigation of the alluvial valley of the lower Mississippi River conducted for the Mississippi River Commission, Vicksburg, Miss.: U.S. Army, Corps of Engineers, 78 p.

Foster, V.M. and McCutcheon, T.E., 1941, Forrest County mineral resources: Mississippi Geological Survey, Bulletin 44, 87 p.

Frascogna, X.M., ed., 1957, Mesozioc-Paleozoic producing areas of Mississippi and Alabama, v. 1: Mississippi Geological Society, 139 p.

Gulf Coast Association of Geological Societies and American Association of Petroleum Geologists, 1972, Tectonic map of Gulf Coast region U.S.A., scale 1:1,000,000.

Halbouty, M.T., 1979, Salt domes, Gulf region, United States and Mexico: Gulf Publishing Co., Houston, Texas, 561 p.

Holdahl, S.R. and Morrison, N.L., 1974, Regional investigations of vertical crustal movements in the U.S., using precise relevelings and mareograph data, in Green, R. ed., Recent crustal movements and associated seismic and volcanic activity: Tectonophysics, 23 (4), pp. 373-390.

Hughes, D.J., 1960, Faulting associated with deep seated salt domes in the northeast portion of the Mississippi Salt Basin: Gulf Coast Association of Geological Societies, Transactions, v. 10, pp 154-173.

Johnson, O.H., 1951, The geology of the Baxterville oil field, Lamar and Marion Counties, Mississippi: Masters thesis, Mississippi State College, 52 p.

Jux, U., 1961, The palynologic age of diapiric and bedded salt in the Gulf Coastal province: Louisiana Geological Survey, Bulletin 38, 46 p.

Karges, H.E., 1975, Petroleum potential of Mississippi shallow salt domes: Gulf Coast Association of Geological Societies, Transactions, v. 25, pp. 168-181.

Knight, W., 1951, Geology of Hub field, Marion County, Mississippi: Gulf Coast Association of Geological Societies, Transactions, v. 1, p. 135-156.

Law Engineering Testing Company, 1979, Geologic evaluation of Gulf Coast salt domes: Report prepared for Office of Waste Isolation Union Carbide Corporation Nuclear Division.

Law Engineering Testing Company, 1980, Earthquake computer data file, Marietta, Georgia.

Lee, K.L., 1978, Subsidence earthquake at a California oil field in Evaluation and Prediction of Subsidence, American Society of Civil Engineers, S. K. Saxeha, Ed., Jan. 1978, p. 549-564.

Logan, W.N., 1908, Clays of Mississippi, part II, Brick clays and clay industry of southern Mississipi: Mississippi Geological Survey, Bulletin 4, 72 p.

May, J.H., 1974, Wayne County geology,, in May, J.H., and others, Wayne County geology and mineral resources: Mississippi Geological Survey Bulletin 117, pp. 13-194.

Mellen, F.F., 1958, Cretaceous shelf sediments of Mississippi: Mississippi Geological Survey, Bulletin 85, 111 p.

Mellen, F.F., 1959, Mississippi mineral resources: Mississippi Geological Survey, Bulletin 86, 110 p.

Mellen, F.F., 1979, Mineral resources of Cypress Creek Dome, T.2N., R.10W, Perry County, Mississippi: unpublished report prepared for Law Engineering Testing Company, Gulf Coast Salt Dome project, 12 p.

Mellen, F.F., 1980, Letter to Law Engineering Testing Company, dated April 23, 1980.

Mississippi Geological Society, 1960, Cenozoic of southeast Mississippi and southwest Alabama, 15th field trip guidebook: Mississippi Geological Society, pp. 7-10.

Mississippi Geological Survey, 1969, Geologic map of Mississippi, scale 1:500,000.

Mississippi State Oil and Gas Board, 1977, Bulletin, v. 77, no. 4, 413p.

Mississippi State Oil and Gas Board, 1978, Bulletin, v. 78, no. 3.

Mississippi State Oil and Gas Board, 1979, Bulletin, v. 80, no. 3, 432 p.

Mississippi State Oil and Gas Board, 1980, Annual Report-1979, no. 4, v. 80.

Morgan, J.K., 1970, the central Mississippi uplift: Gulf Coast Association of Geological Societies, Transactions, v. 20, pp. 91-109.

Murray, G.E., 1961, Geology of the Atlantic and Gulf Coastal provinces of North America: New York, Harper and Brothers, 692 p.

Murray, G.E., 1979, Report on near-dome mineral resources: unpublished report prepared for Law Engineering Testing Company, Gulf Coast Salt Dome project, 73 p.

National Oceanic and Atmospheric Administration earthquake data file, 1979, Special LETCo order for Lat. 28-38N and Long. 86-100W.

Nunnally, J.D. and Fowler, H.F., 1954, Lower Cretaceous stratigraphy of Mississippi: Mississippi Geological Survey, Bulletin 79, 45 p.

Oxley, M.L., Minihan, E., and Ridgway, J.M., 1968, A Study of the Jurassic sediments in portion of Mississippi and Alabama, in Dinkens, T.H., Jr., and others, Jurassic stratigraphy of Mississippi: Mississippi Geological Survey, Bulletin 109, pp. 39-77.

Parks, W.S., and others, 1963, Attala County mineral resources: Mississippi Geological Survey, Bulletin 99, 192 p.

Preliminary determination of epicenters, 1974, U.S. Geological Survey, National Earthquake Information Service.

Preliminary determination of epicenters, 1978, U.S. Geological Survey, National Earthquake Information Service.

Priddy, R.R., 1960, Madison County geology: Mississippi Geological Survey, Bulletin 88, 123 p.

Rainwater, E.H., 1963, Geological history and oil and gas possibilities of Mississippi in Mississippi Geologic Research Papers 1962: Mississippi Geological Survey, Bulletin 97, pp. 77-105.

Rainwater, E.H., 1964, Regional stratigraphy of the Midway and Wilcox in Mississippi in Mississippi Geologic Research Papers 1963: Mississippi Geological Survey, Bulletin 102, pp. 9-31.

Sellards, E.H., 1930, Subsidence in Gulf Coastal plain salt domes: Univ. of Texas, Bull., no. 3001, p. 9-36.

Shows, T.N., Broussard, W.L., and Humphreys, C.P., Jr., 1966, Water for industrial development in Forrest, Greene, Jones, Perry, and Wayne Counties, Mississippi: Mississippi Research and Development Center, 72 p.

Stephenson, L.W. and Monroe, W.H., 1940, The Upper Cretaceous deposits: Mississippi Geological Survey, Bulletin 40, pp 35-60.

Thorsen, Carl E., 1963, Age of growth faulting in Southeast Louisiana: Gulf Coast Association of Geological Societies, Transactions v. 13, pp. 103-110.

U.S. Bureau of the Census, 1970, Census of population, General population characteristics, Mississippi, Final report PC(I)-B26, p. 40.

United States Earthquakes, 1928-1977, U.S. Dept. of Commerce and U.S. Dept. of Interior, Boulder, Colorado.

U.S. Geological Survey, 1953, rev. 1970, Hattiesburg, Mississippi topographic map, scale 1:250,000.

Warren, D.H., Healy, J.H., and Jackson, W.H., 1966, Crustal seismic measurements in southeastern Mississippi: Journal of Geophysical Research, v. 71, pp. 3437-3456.

Williams, C.H., Jr., 1967, George County geology, in Williams, C.H., Jr., Dinkins, T.H., Jr., and McCutcheon, T.E., George County geology and mineral resources: Mississippi Geological Survey: Bulletin 108, pp 74-87.

Worzel, J.L. and Watkins, J.S., 1973, Evolution of the Northern Gulf Coast deduced from geophysical data: Gulf Coast Association of Geological Societies, Transactions, v. 23, pp. 84-91.

13 GEOLOGIC CHARACTERIZATION OF SELECTED DOMES IN THE MISSISSIPPI STUDY AREA

13.1 CYPRESS CREEK DOME

Cypress Creek Dome, a shallow piercement salt dome situated in south-central Perry County, is centered in Sections 8, 9, 16, and 17 of T2N, R10W (Figure 13-1). For the purposes of this study, an arbitrary near-dome area, 11 km (7 mi) in an east-west direction and 14 km (9 mi) north-south, was chosen for characterization and comparison to the study area. For more precise reference, the term supradomal area was chosen to designate that portion of the dome area overlying and enclosed by a surface projection of the -914-meter (-3,000-ft)-MSL salt dome contour.

The study techniques and data utilized to characterize the geology of the dome area are discussed in Chapter 2 (Volume I). The specific types of data used in analyses and data collection locations are shown in Figures 12-10, 13-2, 13-3, and Table 12-2.

13.1.1 DOME GEOMETRY AND COMPOSITION: The geometry of the salt stock is based on computer modeling of detailed gravity, high-resolution seismic, and well data as discussed in Chapter 2 (Volume 1). Based on this model, the Cypress Creek salt stock is an irregular mushroom-shaped pillar with an elliptical, northwesterly oriented base. There is a circumferential salt overhang from about -610 (-2,000) to between -1,829 and -2,438 meters (-6,000 and -8,000 ft) MSL. The overhang is especially prominent on the southern flank of the salt stock. The area of the salt stock increases from less than 5 km^2 (2 mi^2) at -305 meters

(-1,000 ft) MSL to approximately 13 km^2 (5 mi^2) at -610 meters (-2,000 ft) MSL. The area then decreases to approximately 5 km^2 (2 mi^2) at -1,829 meters (-6,000 ft) MSL. The salt stock increases in size to approximately three times this area at -4,572 meters (-15,000 ft) MSL.

Planimetric calculations, shown in the following table, summarize the area of the salt at three levels.

Elevation (ft. MSL)	Depth Range (feet)*	Area (acres)**
-2000	2190 to 2270	3217
-2500	2690 to 2770	2906
-3000	3190 to 3270	2609

---

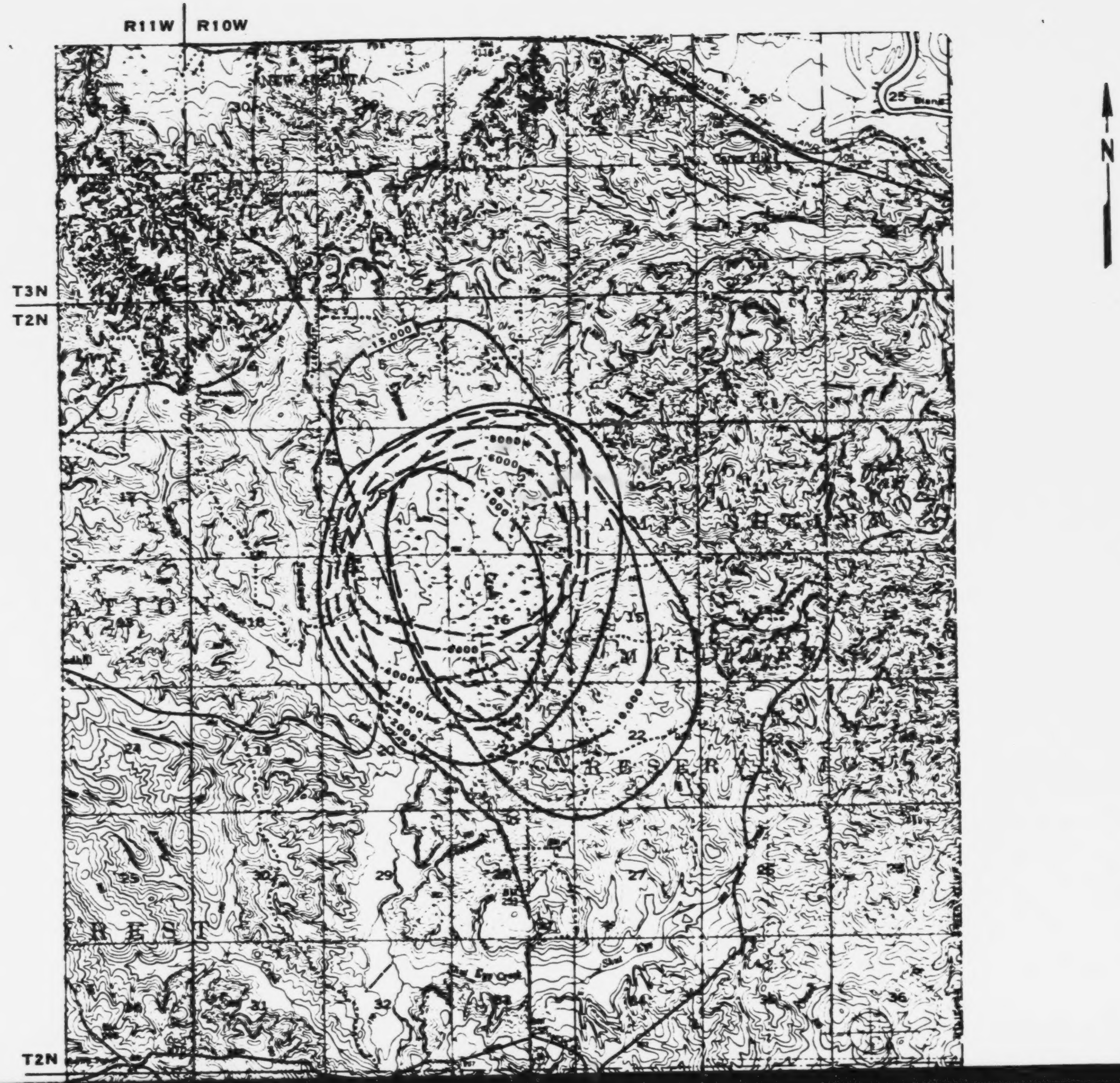
*To convert to meters, multiply by 0.3048.
**To convert to hectares, multiply by 0.4047.

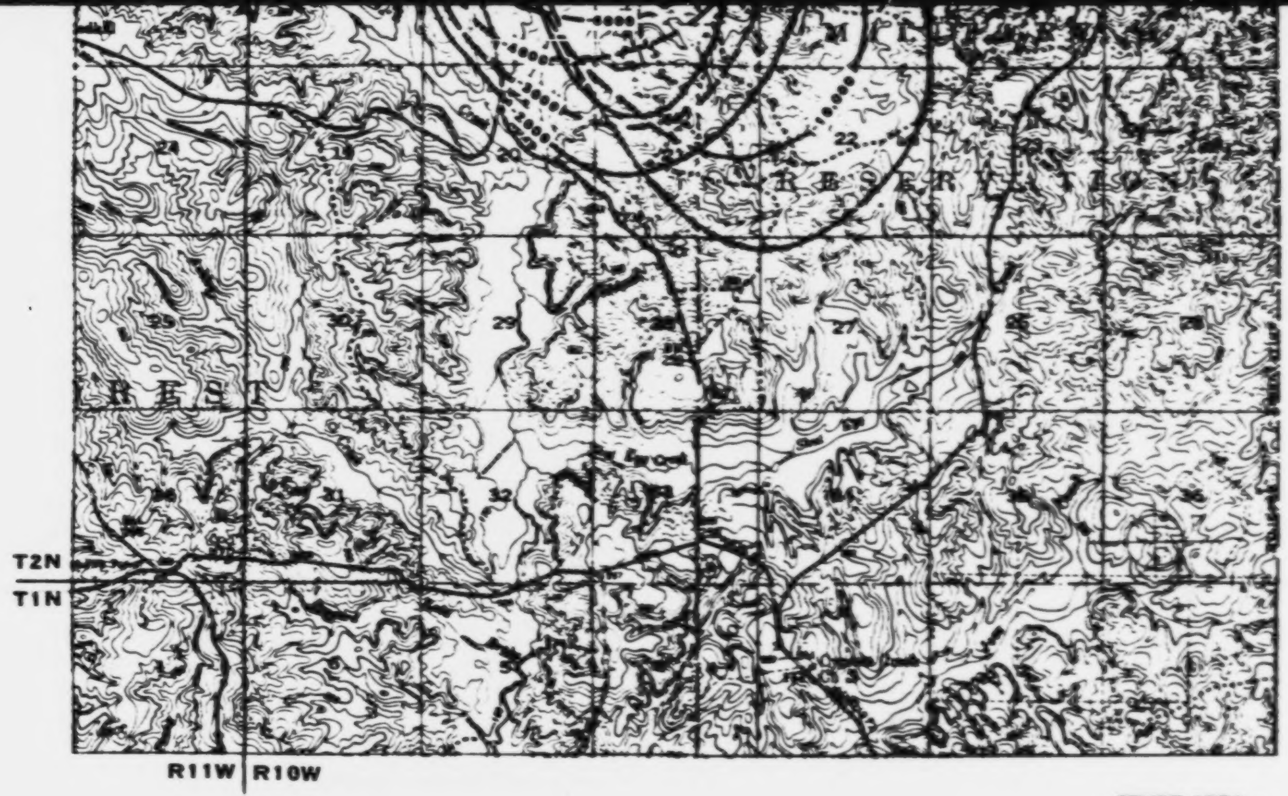
Data from the model, as well as detailed analysis of well log data from wells penetrating the salt overhang, indicate that caprock overlies the salt between -305 and -610 meters (-1,000 and -2,000 ft) MSL. Caprock is present on the underside of the overhang from -610 to -3,048 meters (-2,000 to about -10,000 ft) MSL (Figures 13-4 and 13-5). The drilled thickness of the caprock ranges from 11 to 183 meters (36 to over 600 ft); however, the actual thickness perpendicular to the boundary (edge) of the salt stock can only be inferred (Figure 13-6) without knowing the actual angle of the contact between the borehole and caprock.

Caprock cored in Well DOE MCCG-1 USA consists predominantly of anhydrite and gypsum. Most of the anhydrite occurs as a gray,

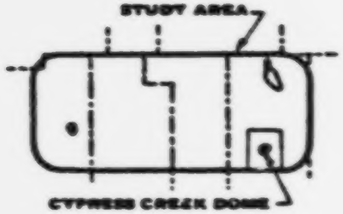
BEST DOCUMENT AVAILABLE

132


R11W
R10W
T3N
T2N
T2N
N
NEW AUGUSTA
12,000
8000
6000
4000
2000
10,000
30
25
25
16
15
17
18
22
27
26
28
29
30
31
32
36



T2N
T1N
R11W
R10W
RESERVATION
20
21
22
27
28
29
30
31
32



STUDY AREA
CYPRESS CREEK DOME

132
A

LEGEND

—1000— LINE OF EQUAL ELEVATION OF SALT.
DASHED BENEATH SALT OVERHANG.
CONTOUR INTERVAL 1000 FEET.

1 0 1 MILES

1 0 1 KILOMETERS

CONTOUR INTERVAL 10 FEET

DATUM IS MEAN SEA LEVEL

BASE FROM U.S. GEOLOGICAL SURVEY 1:62,500 QUADRANGLE

BEST DOCUMENT AVAILABLE

FIGURE 13-1

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1261-1

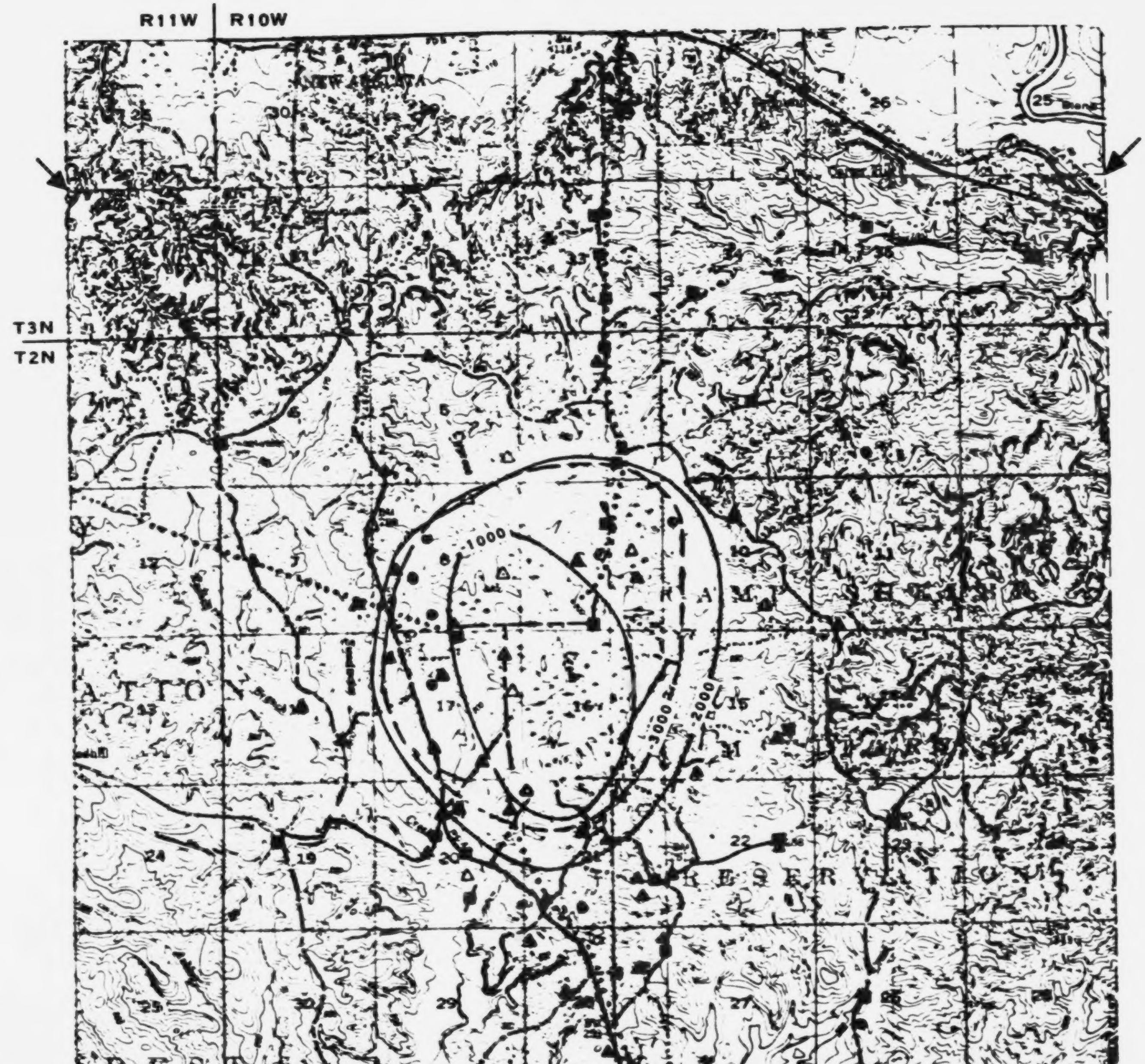
NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

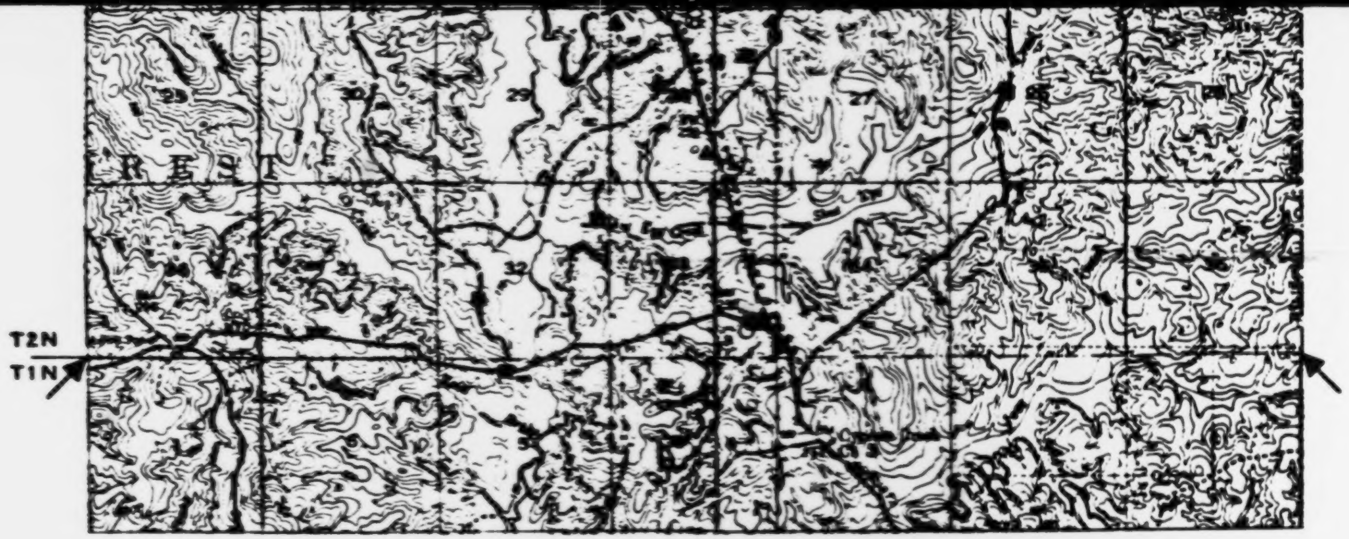
MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
TOPOGRAPHIC MAP WITH STRUCTURE
CONTOURS ON SALT

JOB NO. MV 9600

FIGURE 13-1

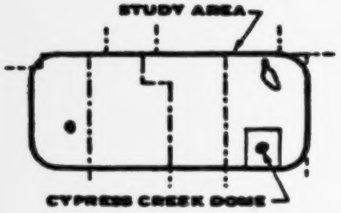

R11W
R10W
T3N
T2N
N
1000
2000
3000

BEST DOCUMENT AVAILABLE



LEGEND

●	OIL OR GAS WELL
○	AREA CHARACTERIZATION HYDROLOGIC BORING
●	AREA CHARACTERIZATION GEOLOGIC BORING
⊙	AREA CHARACTERIZATION SALT CORE BORING
■	GROUND LEVEL RESISTIVITY VERTICAL SOUNDING
▲	AREA CHARACTERIZATION SHALLOW BORING
△	AREA CHARACTERIZATION SHALLOW BORING-UNSURVEYED LOCATION
—— -1000 ——	LINE OF EQUAL ELEVATION OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL 1000 FEET DATUM IS MEAN SEA LEVEL.
— — — —	GROUND LEVEL RESISTIVITY HORIZONTAL PROFILE
••••••••	HIGH RESOLUTION SEISMIC REFLECTION LINE
↗	LIMIT OF GEOLOGIC MAPPING PROGRAM



1
0
1
MILES
1
0
1
KILOMETERS

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
BASE FROM U.S. GEOLOGICAL SURVEY 1:62,500 QUADRANGLE.

FIGURE 13-2

PREPARED J.D.G.	DATE 5-30-80
REVISED [illegible]	DATE [illegible]
REVISED	DATE
APPROVED [illegible]	DATE [illegible]

T-1262-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

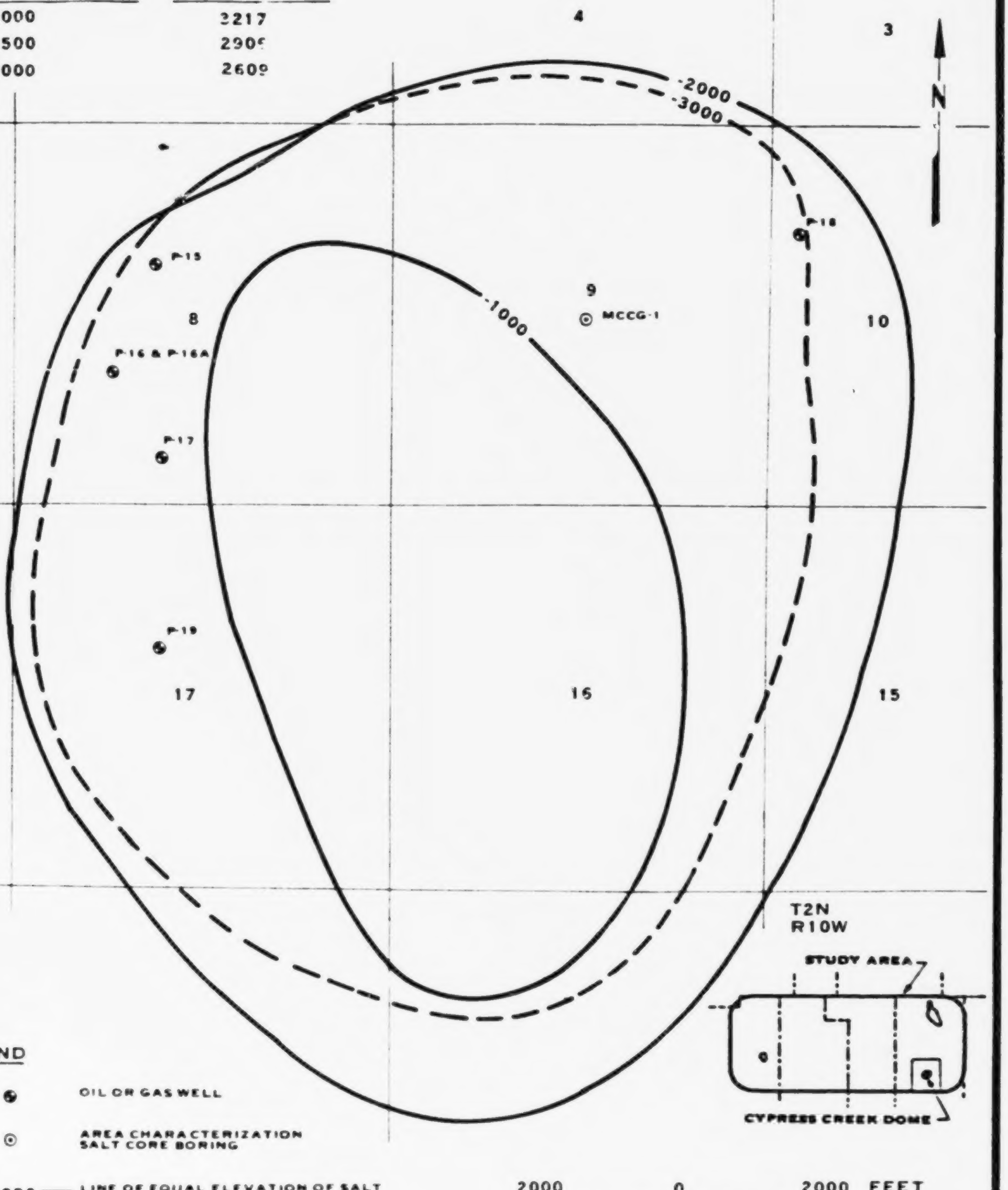
MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
DATA UTILIZED IN ANALYSIS

JOB NO. MV 9600

FIGURE 13-2

BEST DOCUMENT AVAILABLE

ALT CONTOUR EVATION IN FEET MSL)	AREA (ACRES)
-2000	3217
-2500	2909
-3000	2609


4
3
N
-2000
-3000
P-18
P-15
9
MCCG-1
8
10
-1000
P-16 & P-16A
P-17
P-19
17
16
15
T2N
R10W
STUDY AREA
CYPRESS CREEK DOME

LEGEND

● OIL OR GAS WELL

⊙ AREA CHARACTERIZATION SALT CORE BORING

—-1000— LINE OF EQUAL ELEVATION OF SALT DASHED BENEATH SALT OVERHANG INTERVAL 1000 FEET DATUM IS MEAN SEA LEVEL

2000 0 2000 FEET
0.5 0 0.5 KILOMETERS

WELL KEY IN TABLE 12-3
TOTAL AREA DETERMINED BY PLANIMETER METHOD

REPARED LDG DATE 3-78
EVISED ________ DATE____
EVISED ________ DATE____
PPROVED CEP DATE 3-78

T-1263-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

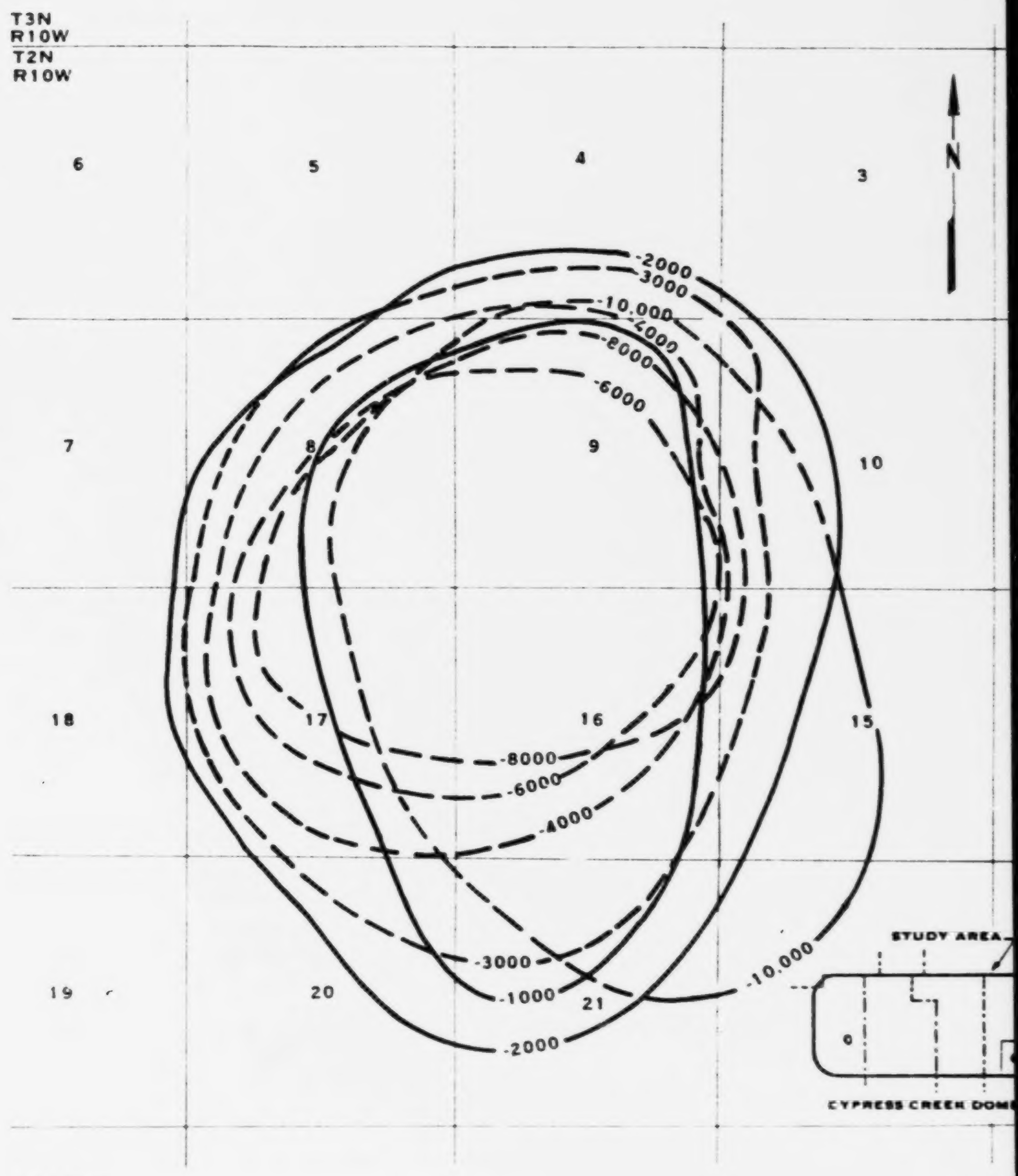
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
WELL LOCATION MAP

JOB NO. MV9600 FIGURE 13-3

[redacted]

BEST DOCUMENT AVAILABLE


T3N
R10W
T2N
R10W
6
5
4
3
N
-2000
3000
-10,000
-4000
-8000
-6000
7
8
9
10
18
17
16
15
-8000
-6000
-4000
STUDY AREA
-10,000
-3000
19
20
-1000
21
-2000
0
CYPRESS CREEK DOME

LEGEND

—-1000— LINE OF EQUAL ELEVATION OF CAPROCK
DASHED BENEATH CAPROCK OVERHANG
INTERVAL 1000 FEET. DATUM IS MEAN SEA LEVEL

3000 0 3000 FEET
0.5 0 0.5 KILOME

PREPARED J.D.G. DATE 12-4-8
REVISED ______ DATE ____
REVISED ______ DATE ____
APPROVED Dip DATE 12-4-8
T-1264-1

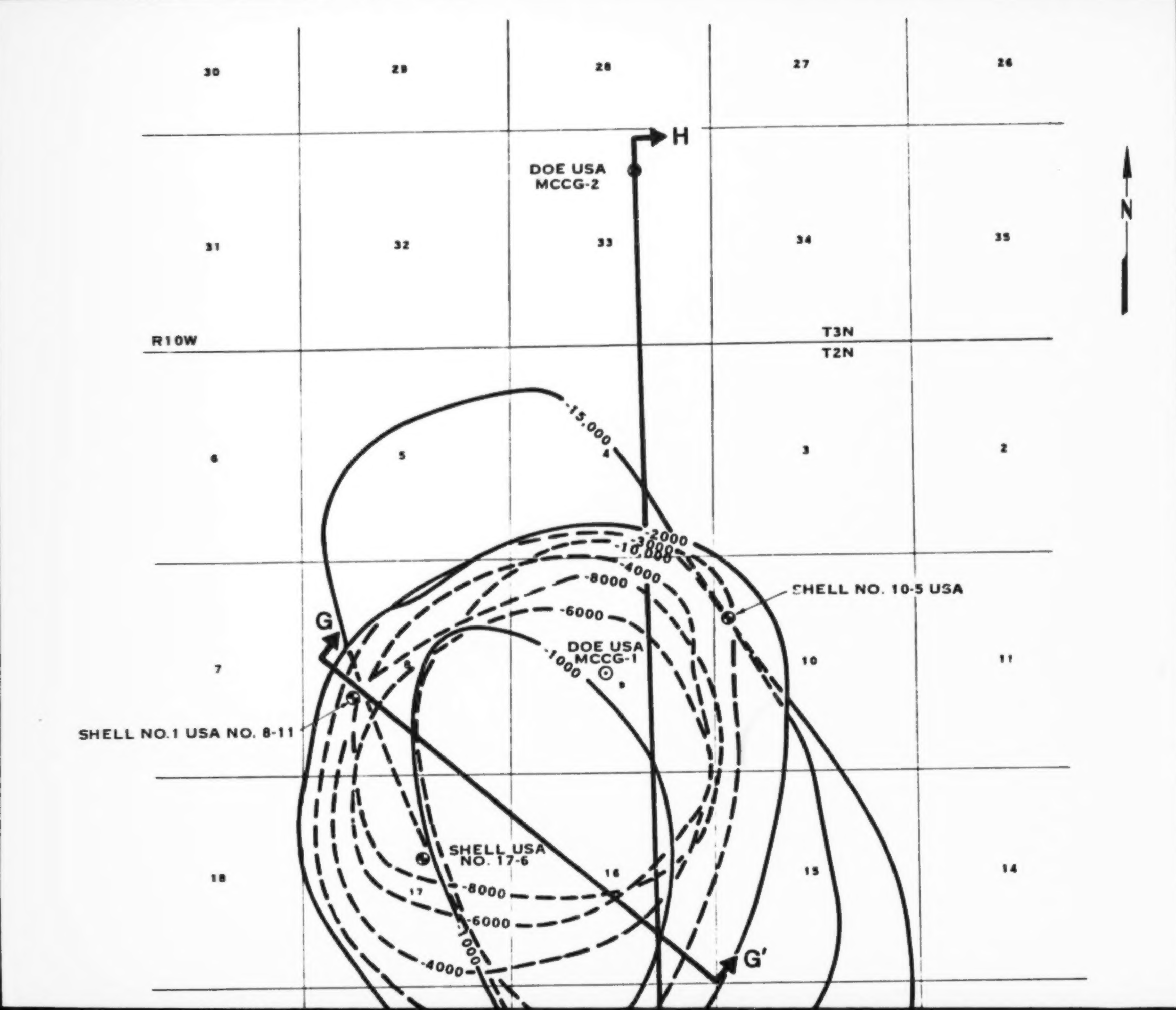
NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY ARE
CYPRESS CREEK DOME
STRUCTURE CONTOUR MA
TOP OF CAPROCK

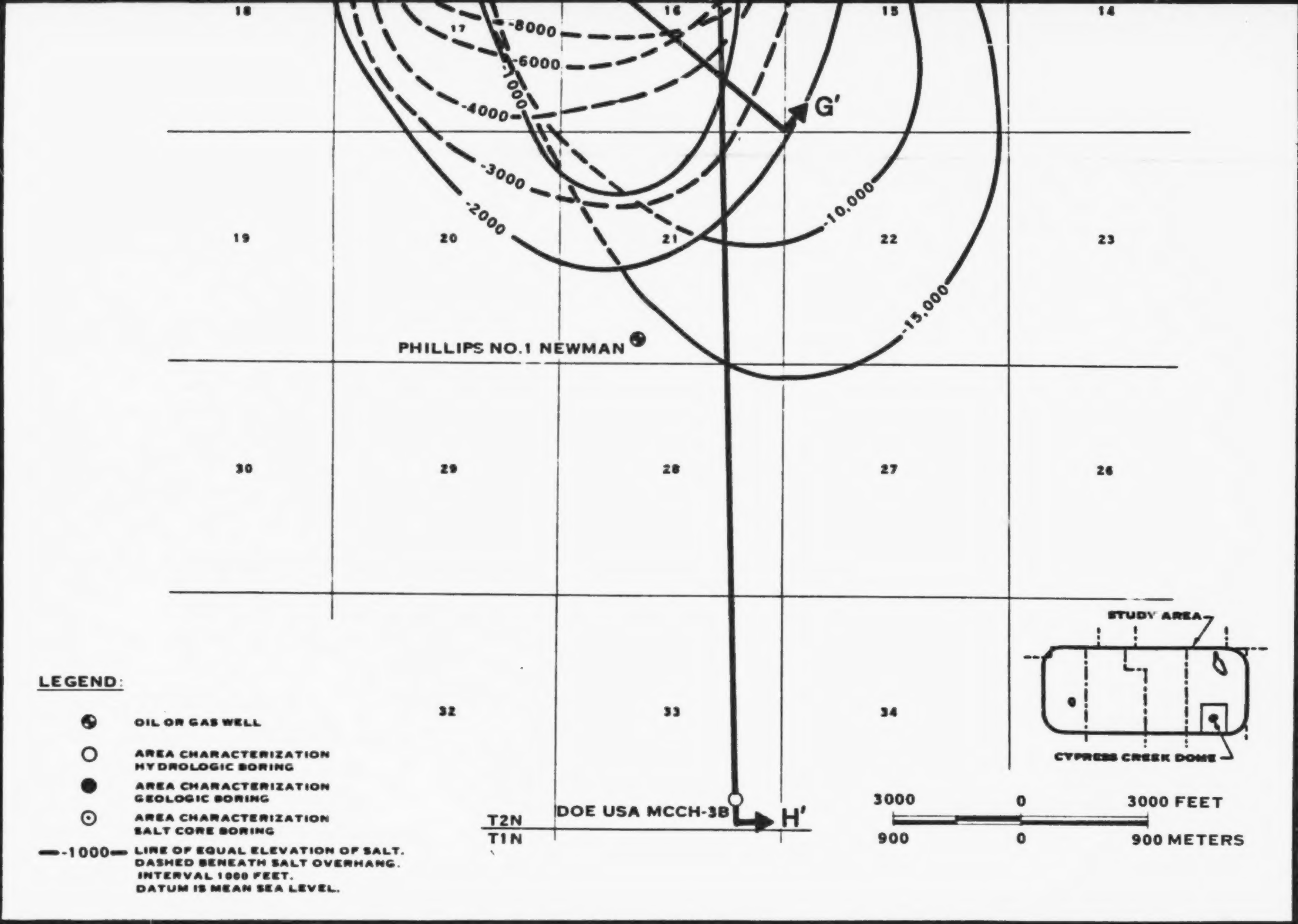
JOB NO. MV9600 FIGUR

BEST DOCUMENT AVA

136


30
29
28
27
26
H
DOE USA
MCCG-2
N
31
32
33
34
35
R10W
T3N
T2N
-15,000
6
5
4
3
2
-2000
-3000
-10,000
-4000
-8000
SHELL NO. 10-5 USA
-6000
G
DOE USA
MCCG-1
-1000
7
8
9
10
11
SHELL NO.1 USA NO. 8-11
SHELL USA
NO. 17-6
18
17
16
15
14
-8000
-6000
-4000
-1000
G'

136A


18
17
16
15
14
-8000
-6000
-7000
-4000
G'
-3000
-2000
-10,000
19
20
21
22
23
-15,000
PHILLIPS NO.1 NEWMAN
30
29
28
27
26
STUDY AREA
CYPRESS CREEK DOME
LEGEND:
OIL OR GAS WELL
AREA CHARACTERIZATION HYDROLOGIC BORING
AREA CHARACTERIZATION GEOLOGIC BORING
AREA CHARACTERIZATION SALT CORE BORING
-1000 LINE OF EQUAL ELEVATION OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL 1000 FEET. DATUM IS MEAN SEA LEVEL.
32
33
34
T2N
T1N
DOE USA MCCH-3B
H'
3000
0
3000 FEET
900
0
900 METERS

PREPARED J.D.G. DATE 12-4-81
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED DJ DATE 12/9/81

T-1265-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

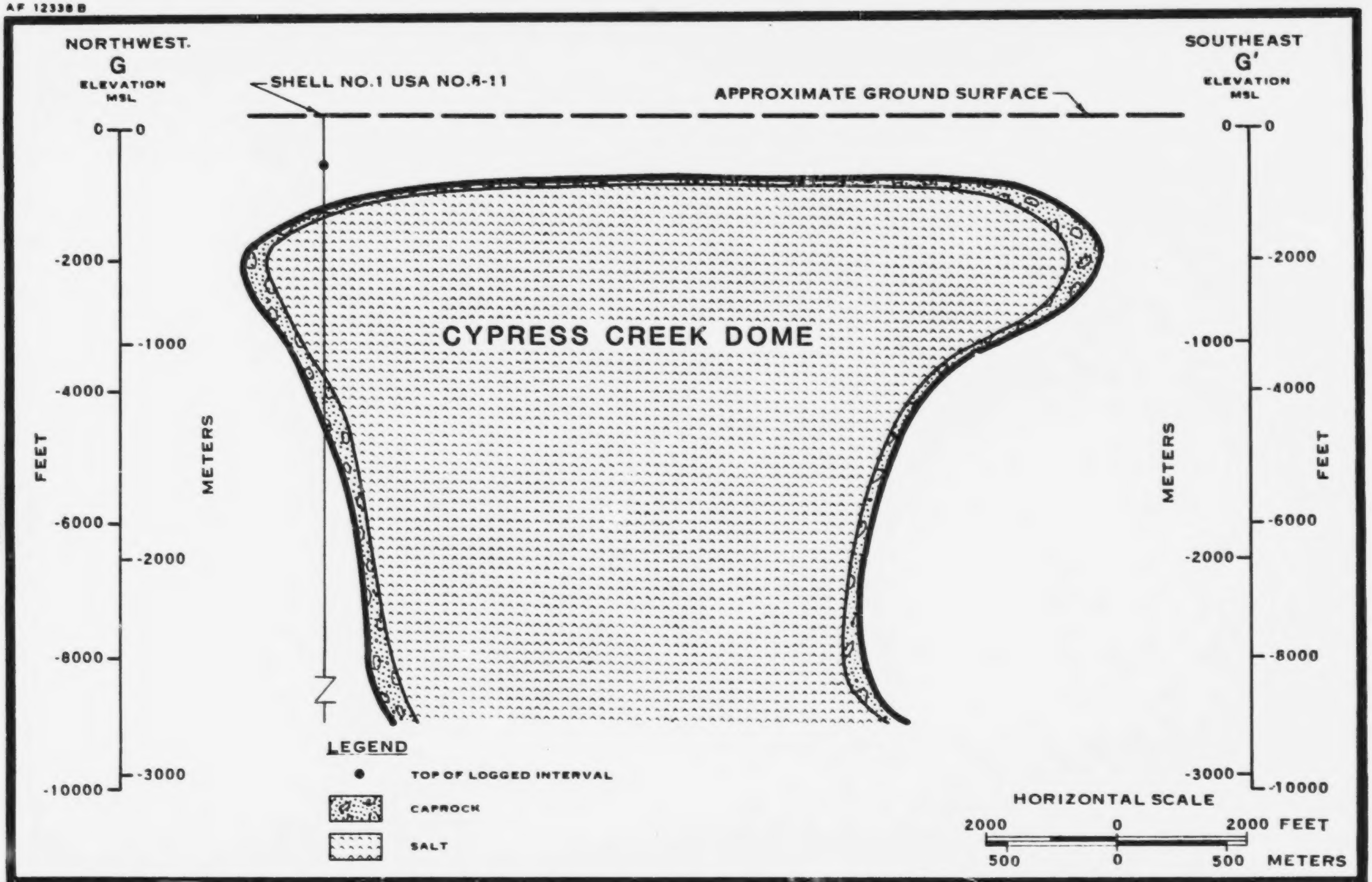
MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
LOCATION MAP
GEOLOGIC SECTIONS G-G' AND H-H'

JOB NO. MV9600

FIGURE 13-5

BEST DOCUMENT AVAILABLE

AF 12338 B


NORTHWEST
G
ELEVATION MSL
SOUTHEAST
G'
ELEVATION MSL
SHELL NO.1 USA NO.8-11
APPROXIMATE GROUND SURFACE
CYPRESS CREEK DOME
FEET
METERS
0
-2000
-4000
-6000
-8000
-10000
-1000
-2000
-3000
LEGEND
TOP OF LOGGED INTERVAL
CAPROCK
SALT
HORIZONTAL SCALE
2000 0 2000 FEET
500 0 500 METERS

PREPARED	V.D.G.	DATE	12-4-81
REVISED		DATE	
REVISED		DATE	
APPROVED	OGP	DATE	12/4/81

T-1435-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
TRUE SCALE DOME SECTION G - G'

JOB NO. MV9500

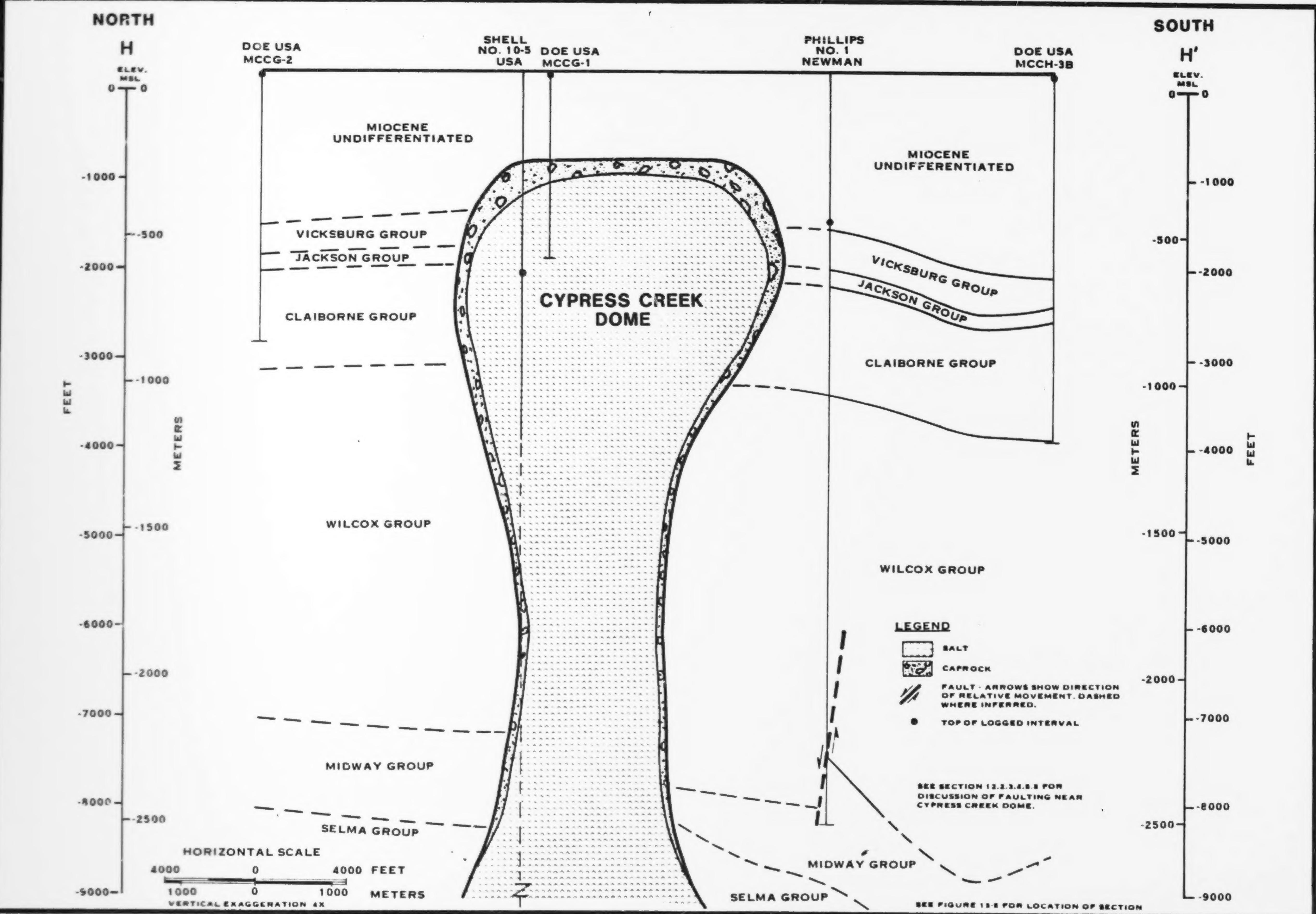
FIGURE 13-6

FIGURE 12-6

BEST DOCUMENT AVAILABLE

coarse groundmass, with lighter-colored anhydrite blebs or stringers. Fine-grain gypsum appears to have replaced the anhydrite in zones in the upper part of the core. The lower portion of the caprock core contains approximately 80 percent anhydrite, with the remainder consisting of gypsum in veins, filling fractures, and in small blebs. Near the caprock/salt contact gypsum veins are absent and the anhydrite grades into granular halite. The average anhydrite content of the entire caprock core is approximately 80 percent. Geophysical logs from exploratory wells drilled through the dome overhang indicate that about 3 to 189 meters (10 to 620 ft) of anhydrite exists below the overhang.

The shallowest salt contour based on the gravity model (Figure 13-1) is at -305 meters (-1,000 ft) MSL, which corresponds to a depth of approximately 363 meters (1,190 ft). In five petroleum exploration wells for which records are available, as well as in the DOE MCCG-1 USA well, salt was encountered at depths of 387 to 430 meters (1,271 to 1,410 ft), which corresponds to elevations of -316 to -361 meters (-1,037 to -1,184 ft) MSL. The DOE MCCG-1 USA core extended 156 meters (513 ft) into the salt at total depth (Figure 13-7). The salt in this core consists of fine to coarse-grain, equidimensional or prolate halite crystals with anhydrite bands and xenoliths present throughout. The salt core generally contains less than 10 percent anhydrite, with discrete bands in the core which are up to 25 percent anhydrite. Geophysical logs from preexisting exploratory wells drilled through the salt overhang indicate that evaporite minerals other than halite are present in the salt stock.


NORTH
H
ELEV. MSL.
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
FEET
-500
-1000
-1500
-2000
-2500
METERS
DOE USA MCCG-2
SHELL NO. 10-5 USA
DOE USA MCCG-1
PHILLIPS NO. 1 NEWMAN
DOE USA MCCH-3B
SOUTH
H'
MIOCENE UNDIFFERENTIATED
VICKSBURG GROUP
JACKSON GROUP
CLAIBORNE GROUP
CYPRESS CREEK DOME
WILCOX GROUP
MIDWAY GROUP
SELMA GROUP
HORIZONTAL SCALE
4000 0 4000 FEET
1000 0 1000 METERS
VERTICAL EXAGGERATION 4X
LEGEND
SALT
CAPROCK
FAULT - ARROWS SHOW DIRECTION OF RELATIVE MOVEMENT. DASHED WHERE INFERRED.
TOP OF LOGGED INTERVAL
SEE SECTION 12.2.3.4.5.5 FOR DISCUSSION OF FAULTING NEAR CYPRESS CREEK DOME.
SEE FIGURE 13-6 FOR LOCATION OF SECTION

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
GEOLOGIC SECTION H - H'

FIGURE 13-7

JOB NO. MV9600

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED DATE 12/16/81

T-1266-1

To supplement the gravity modeling, three high-resolution seismic reflection lines were shot during Area Characterization to help define the dome geometry to about -914 meters (-3,000 ft) MSL (Figures 13-9 to 13-11). These lines were located on the northern, southern, and western flanks of the dome (Figure 13-8).

13.1.2 NEAR-DOME GEOLOGY: This section describes surface features as well as the stratigraphy and structure of the beds in the near-dome area.

13.1.2.1 Surface Features: The Cypress Creek near-dome area, situated within the Piney Woods Physiographic Subprovince, has a surface development typical of the Mississippi Study Area. The land surface is gently rolling to hilly with moderate topographic relief. The Hattiesburg and Citronelle Formations, which are exposed in the near-dome area, are maturely dissected in a dendritic pattern of drainage (Figure 13-12). A broad swamp which occupies the supradomal area may be the modern surface expression of subsidence over the dome. Terraces exist only as isolated remnants, principally within the flood plain of Cypress Creek.

Land use is generally limited to managed pine forest and military training activities. According to the U.S. Bureau of the Census, Perry County had a 1970 population of 9,065, which corresponds to a distribution of about 14 people per square mile. Development of near-surface mineral resources is discussed in Section 13.1.3.

The near-dome area is located within the DeSoto National Forest, which includes Camp Shelby, a military training facility. Approximately 90 percent of the near-dome area is applied to commercial forestry. The remainder consists of isolated parcels of privately owned land except for Section 16, overlying the supradomal area, which is owned by Perry County. Less than about 5 percent of the near-dome area is under cultivation or in pasture land. The town of New Augusta, population 662, lies at the northern edge of the area, approximately 5 km (3 mi) northwest of the supradomal area.

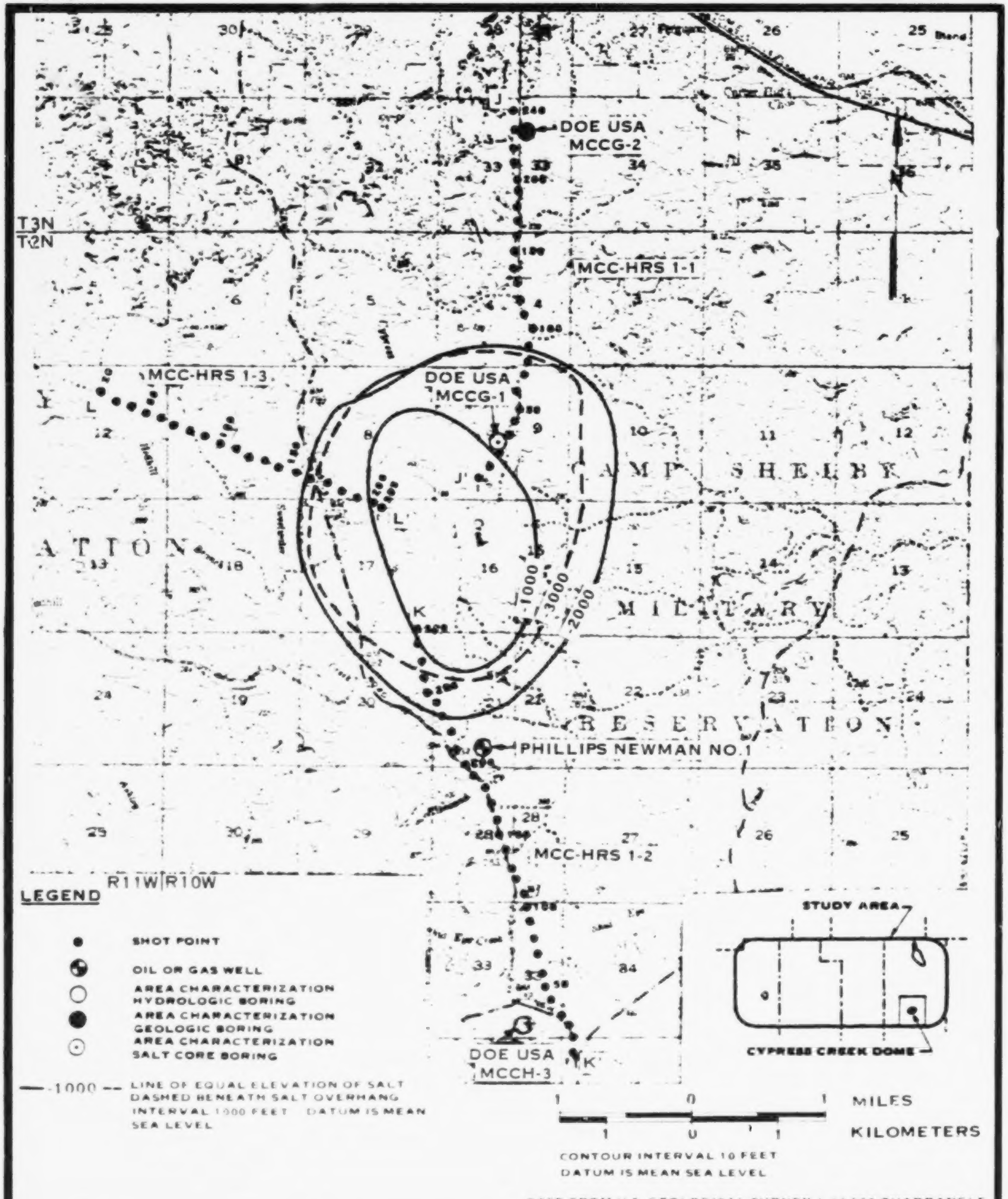
Surface elevations range from a low of 21 meters (70 ft) MSL on the Leaf River flood plain in the northeast corner of the near-dome area, to a high of 99 meters (325 ft) in the east-central portion of the near-dome area (Figure 13-1). Elevations over the supradomal area vary from 55 meters (180 ft) MSL in the swamp, within the flood plain of Cypress Creek, to about 82 meters (270 ft) on the ridges surrounding the swamp.

The absence of positive relief concentric to the supradomal area suggests that there has been no post-depositional upward domal movement to deform the exposed beds. The supradomal area consists of a broad, gently rolling to flat-bottomed valley encircled by a series of linear knobs which are characteristic of the surrounding, more rugged terrain (Figure 13-13)*. Thus, the

---

*The topographic net (Figure 13-13) is included in this volume to illustrate computer applications to geomorphic analyses. The Mississippi domes are especially adaptable to the perspective presentation of topographic data.

AF 12338A



30
29
28
27
26
25
J
DOE USA
MCCG-2
33
34
35
36
T3N
T2N
MCC-HRS 1-1
6
5
4
2
1
MCC-HRS 1-3
DOE USA
MCCG-1
L
12
8
9
10
11
12
J'
CAMP SHELBY
L'
13
18
17
16
15
14
13
K
1000
3000
2000
MILITARY
24
19
20
21
22
23
24
RESERVATION
PHILLIPS NEWMAN NO.1
25
30
29
28
27
26
25
MCC-HRS 1-2
R11W
R10W
33
34
DOE USA
MCCH-3
K'
LEGEND
SHOT POINT
OIL OR GAS WELL
AREA CHARACTERIZATION HYDROLOGIC BORING
AREA CHARACTERIZATION GEOLOGIC BORING
AREA CHARACTERIZATION SALT CORE BORING
—1000— LINE OF EQUAL ELEVATION OF SALT DASHED BENEATH SALT OVERHANG INTERVAL 1000 FEET DATUM IS MEAN SEA LEVEL
STUDY AREA
CYPRESS CREEK DOME
1
0
1
MILES
1
0
1
KILOMETERS
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

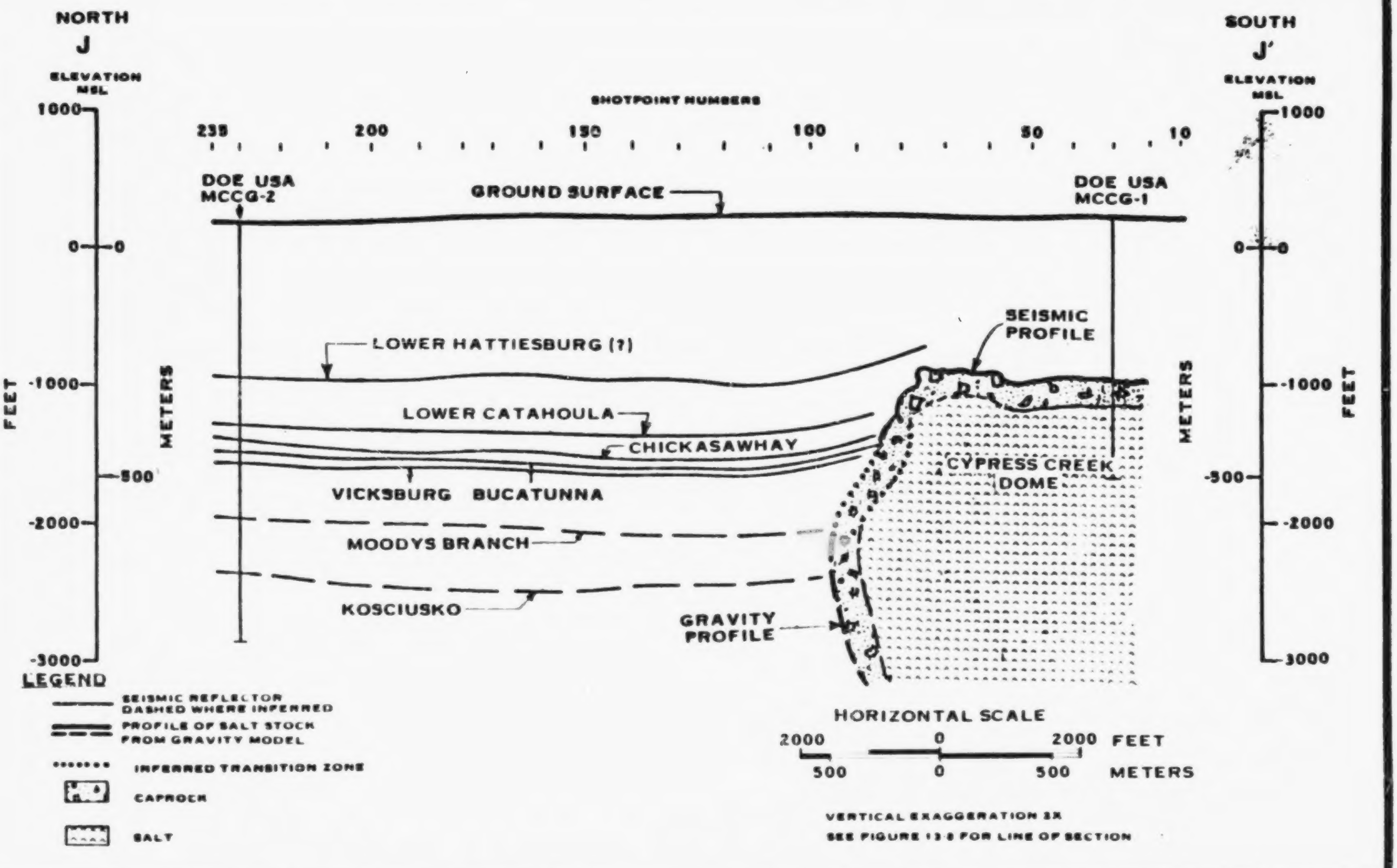
BASE FROM U.S. GEOLOGICAL SURVEY 1:62,500 QUADRANGLE

PREPARED *JRG* DATE *12-78*
REVISED ______ DATE ___
REVISED ______ DATE ___
APPROVED *DGP* DATE *1-4-79*
T-1412-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
LOCATION MAP
HIGH RESOLUTION
SEISMIC SECTIONS J-J', K-K' & L-L'
JOB NO. MV9600 FIGURE 13-8

BEST DOCUMENT AVAILABLE

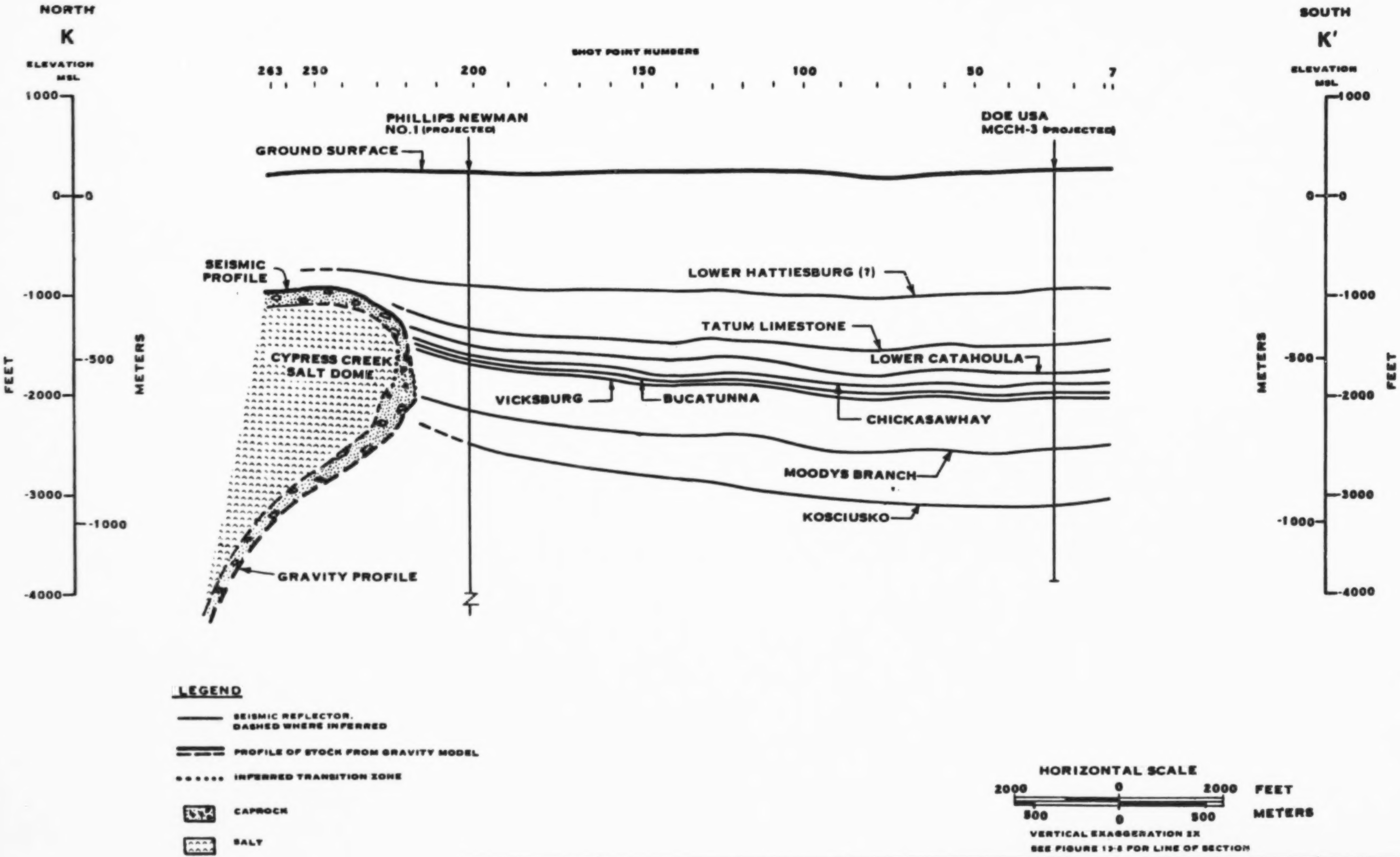

NORTH
J
ELEVATION MSL
SOUTH
J'
ELEVATION MSL
SHOTPOINT NUMBERS
235
200
150
100
50
10
1000
0
-1000
-2000
-3000
500
-500
FEET
METERS
DOE USA MCCG-2
DOE USA MCCG-1
GROUND SURFACE
SEISMIC PROFILE
LOWER HATTIESBURG (?)
LOWER CATAHOULA
CHICKASAWHAY
VICKSBURG
BUCATUNNA
CYPRESS CREEK DOME
MOODYS BRANCH
KOSCIUSKO
GRAVITY PROFILE
LEGEND
SEISMIC REFLECTOR DASHED WHERE INFERRED
PROFILE OF SALT STOCK FROM GRAVITY MODEL
INFERRED TRANSITION ZONE
CAPROCK
SALT
HORIZONTAL SCALE
2000
0
2000
FEET
500
0
500
METERS
VERTICAL EXAGGERATION 3X
SEE FIGURE 13-8 FOR LINE OF SECTION

PREPARED JDG DATE 12-4-81
REVISED ________ DATE ________
REVISED ________ DATE ________
APPROVED DG DATE 12/?/81
T-1414-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
HIGH RESOLUTION SEISMIC CROSS-SECTION J-J'
JOB NO MV9600
FIGURE 13-9

BEST DOCUMENT AVAILABLE


NORTH
K
ELEVATION MSL
SOUTH
K'
ELEVATION MSL
SHOT POINT NUMBERS
263
250
200
150
100
50
7
1000
0
-1000
-2000
-3000
-4000
FEET
-500
-1000
METERS
PHILLIPS NEWMAN NO.1 (PROJECTED)
DOE USA MCCH-3 (PROJECTED)
GROUND SURFACE
SEISMIC PROFILE
LOWER HATTIESBURG (?)
TATUM LIMESTONE
LOWER CATAHOULA
CYPRESS CREEK SALT DOME
VICKSBURG
BUCATUNNA
CHICKASAWHAY
MOODYS BRANCH
KOSCIUSKO
GRAVITY PROFILE
LEGEND
SEISMIC REFLECTOR. DASHED WHERE INFERRED
PROFILE OF STOCK FROM GRAVITY MODEL
INFERRED TRANSITION ZONE
CAPROCK
SALT
HORIZONTAL SCALE
2000
0
2000
FEET
500
0
500
METERS
VERTICAL EXAGGERATION 2X
SEE FIGURE 13-8 FOR LINE OF SECTION

PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED DAP DATE 12/4/81
T-1415-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
HIGH RESOLUTION
SEISMIC CROSS SECTION K - K'

JOB NO. MV9600
FIGURE 13-10

BEST DOCUMENT AVAILABLE

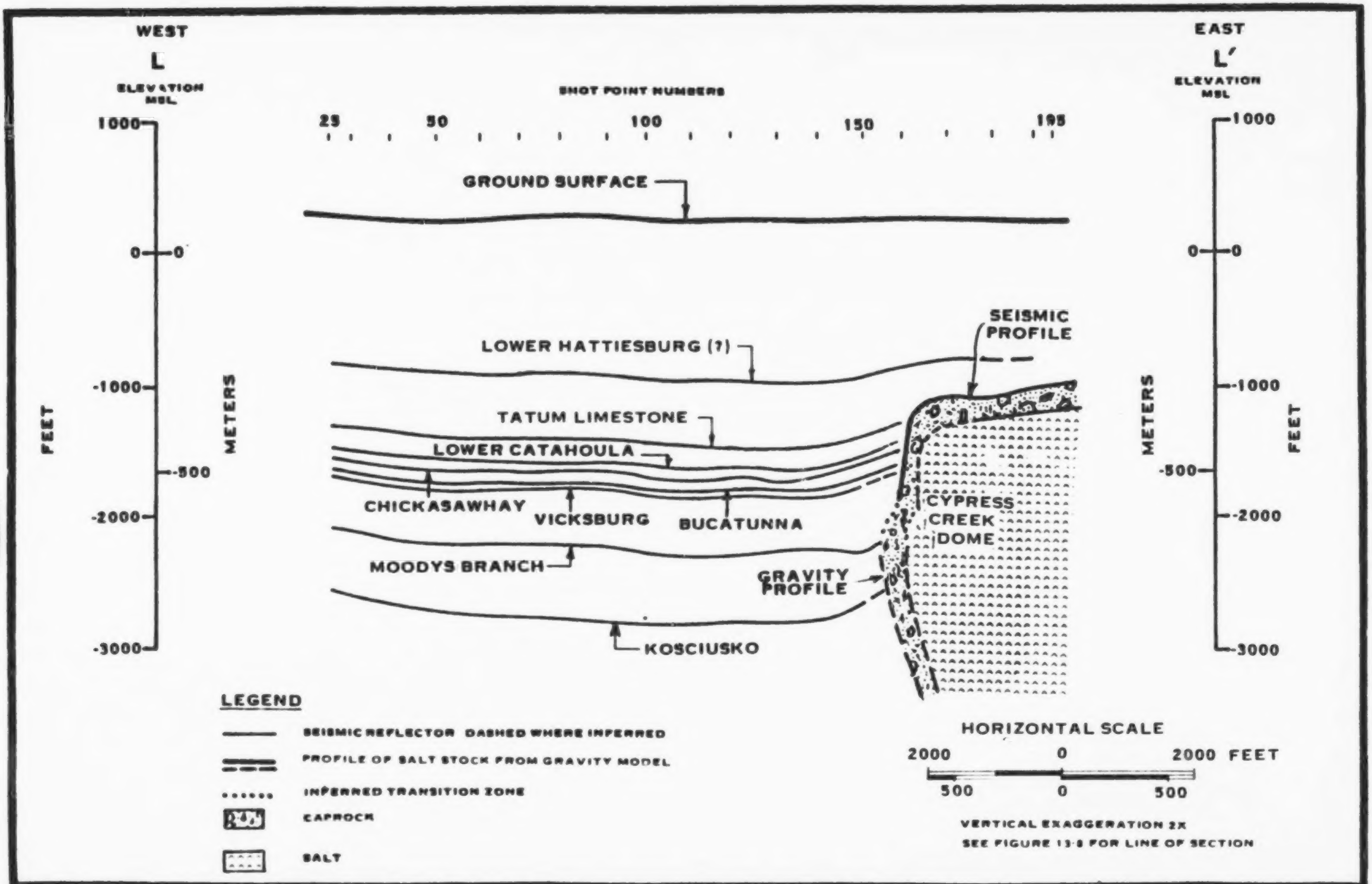

WEST
L
ELEVATION MSL
SHOT POINT NUMBERS
25
50
100
150
195
EAST
L'
ELEVATION MSL
1000
0
-1000
-2000
-3000
FEET
0
-500
METERS
GROUND SURFACE
LOWER HATTIESBURG (?)
SEISMIC PROFILE
TATUM LIMESTONE
LOWER CATAHOULA
CHICKASAWHAY
VICKSBURG
BUCATUNNA
CYPRESS CREEK DOME
MOODYS BRANCH
GRAVITY PROFILE
KOSCIUSKO
LEGEND
SEISMIC REFLECTOR DASHED WHERE INFERRED
PROFILE OF SALT STOCK FROM GRAVITY MODEL
INFERRED TRANSITION ZONE
CAPROCK
SALT
HORIZONTAL SCALE
2000
0
2000 FEET
500
0
500
VERTICAL EXAGGERATION 2X
SEE FIGURE 13-8 FOR LINE OF SECTION

FIGURE 13-11

PREPARED V.D.G. DATE 12-4-81
REVISED DATE
REVISED . DATE
APPROVED D.y. DATE 12/7/81
T-1416-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
HIGH RESOLUTION
SEISMIC SECTION L - L'
JOB NO. MV9800
FIGURE 13-11

BEST DOCUMENT AVAILABLE

185

area overlying the supradomal area is anomalous relative to the surrounding area in its lack of relief and its low topography.

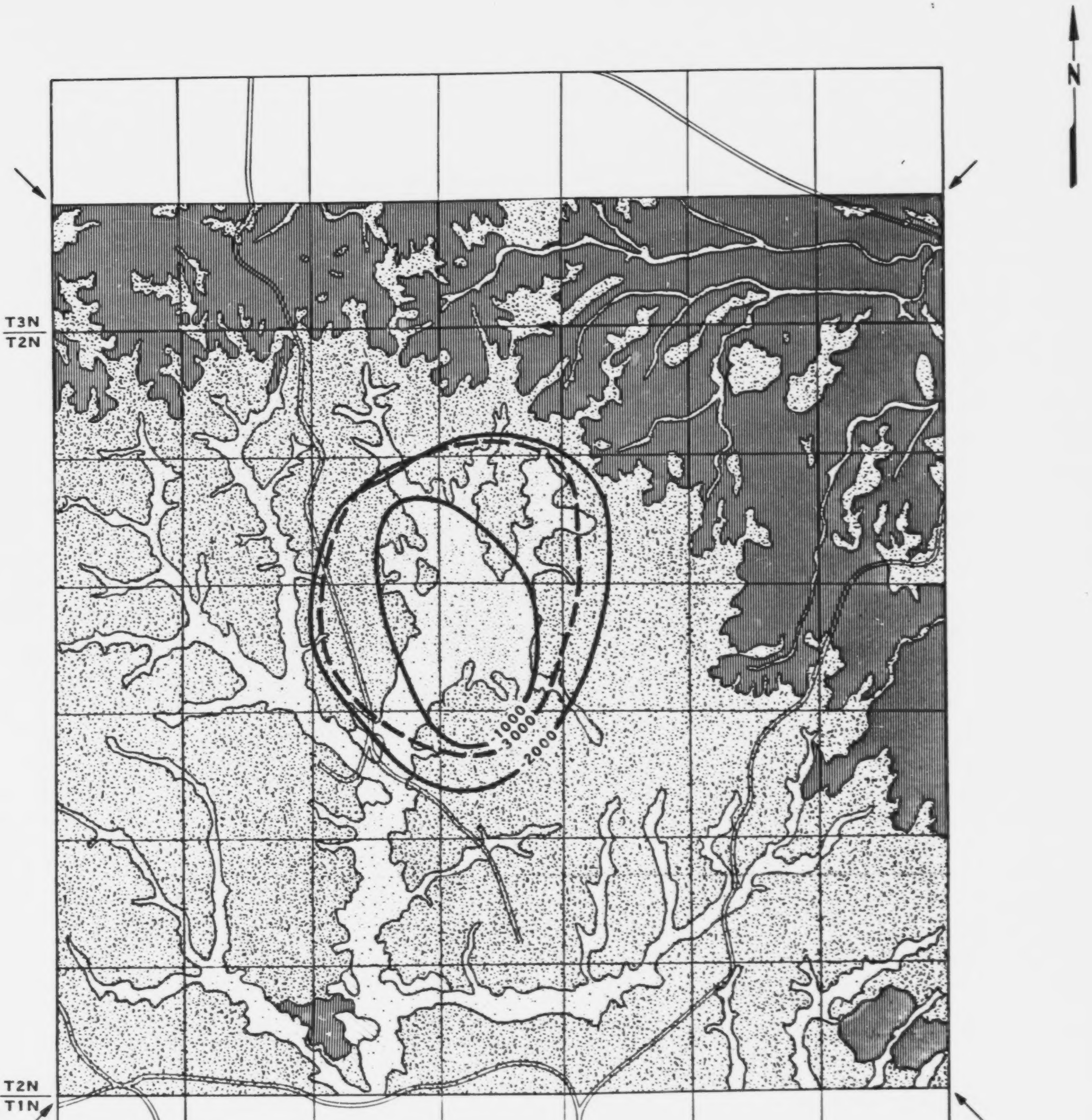
The area is swampy and it is dominated by the flood plain of Cypress Creek, which flows southerly across the dome. The creek bed is considerably wider over the dome than it is either upstream or downstream. This surficial morphology suggests local subsidence in the supradomal area. The course of Cypress Creek changes rather abruptly across the dome from southeasterly to a southwesterly course (Figure 13-14). This is anomalous relative to nearby channels of equivalent order. Other major drainage channels in the near-dome area are generally parallel to each other and they flow either in a southeasterly or a southwesterly direction.

The drainage divide between the Leaf River and Black Creek crosses the near-dome area. North and east of the supradomal area the streams flow into the Leaf River (Figure 13-14). South and west of the divide the streams flow into Black Creek, which flows about 16 km (10 mi) south of the near-dome area (Figure 12-1). The divide trends in an easterly direction north of the supra-domal area and in a southeasterly direction east of this area, approximately coinciding with the Hattiesburg-Citronelle surface contact (Figure 13-12).

Field mapping during the Area Characterization study indicated that drainage in the near-dome area is dominantly controlled by the lithology of the surficial strata. A generally open dendritic drainage pattern coincides with the outcrop of the sands and gravelly sands of the Citronelle Formation (Figures

147

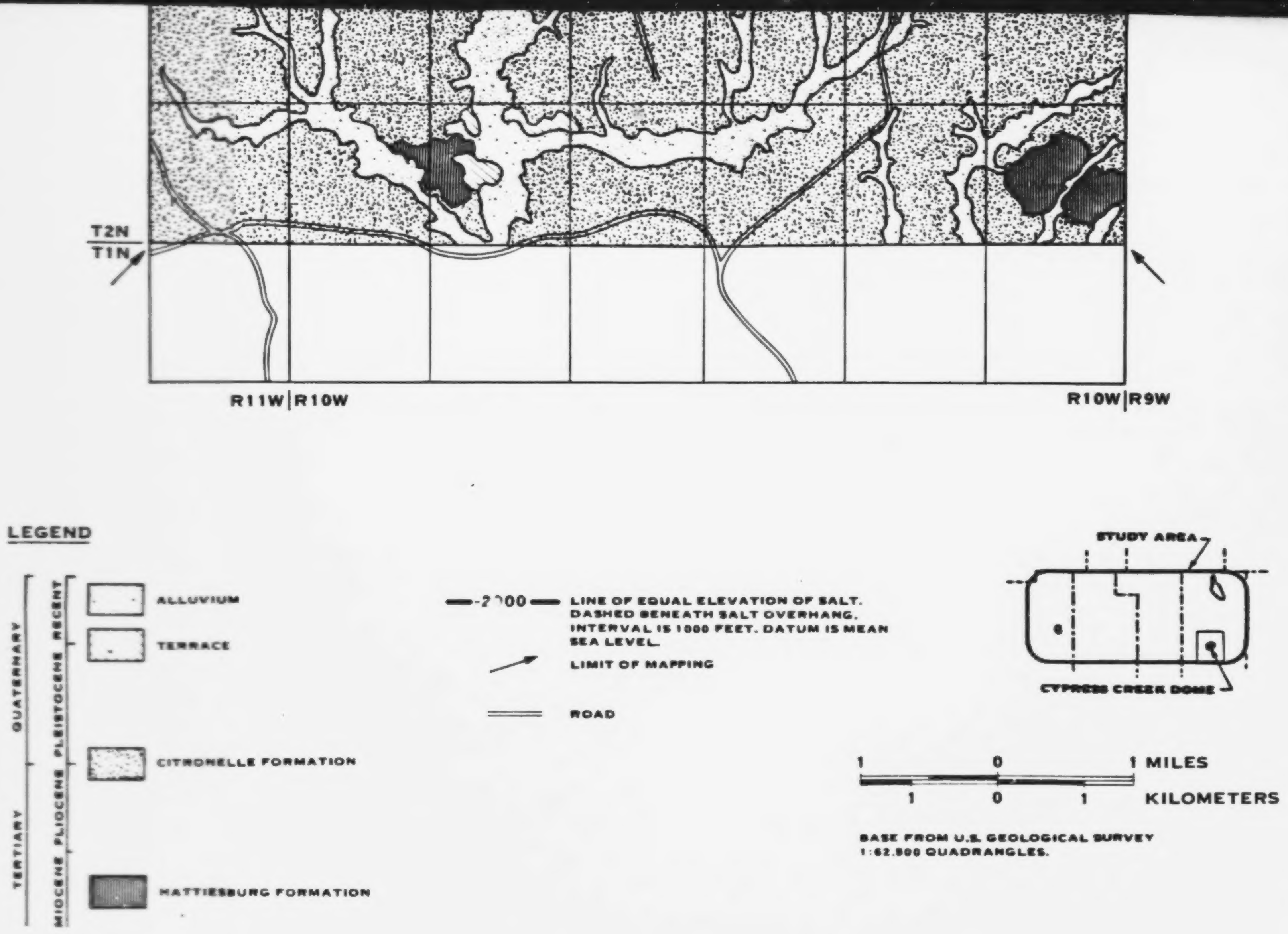
BEST DOCUMENT AVAILABLE


N
T3N
T2N
T2N
T1N
1000
3000
2000
R11W | R10W
R10W | R9W

LEGEND

STUDY AREA

147A



T2N
T1N
R11W | R10W
R10W | R9W
LEGEND
QUATERNARY
TERTIARY
RECENT
PLEISTOCENE
PLIOCENE
MIOCENE
ALLUVIUM
TERRACE
CITRONELLE FORMATION
HATTIESBURG FORMATION
-2000 LINE OF EQUAL ELEVATION OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL IS 1000 FEET. DATUM IS MEAN SEA LEVEL.
LIMIT OF MAPPING
ROAD
STUDY AREA
CYPRESS CREEK DOME
1 0 1 MILES
1 0 1 KILOMETERS

BASE FROM U.S. GEOLOGICAL SURVEY 1:62,500 QUADRANGLES.

PREPARED J.D.G. DATE 12-4-81
REVISED ________ DATE ________
REVISED ________ DATE ________
APPROVED ________ DATE 12/7/81

T-1267-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
GEOLOGIC MAP

JOB NO. MV9600

FIGURE 13-12

FIGURE 13-12

BEST DOCUMENT AVAILABLE

13-12 and 13-14). A more intricate dendritic pattern is developed on the silts and clays of the Hattiesburg Formation.

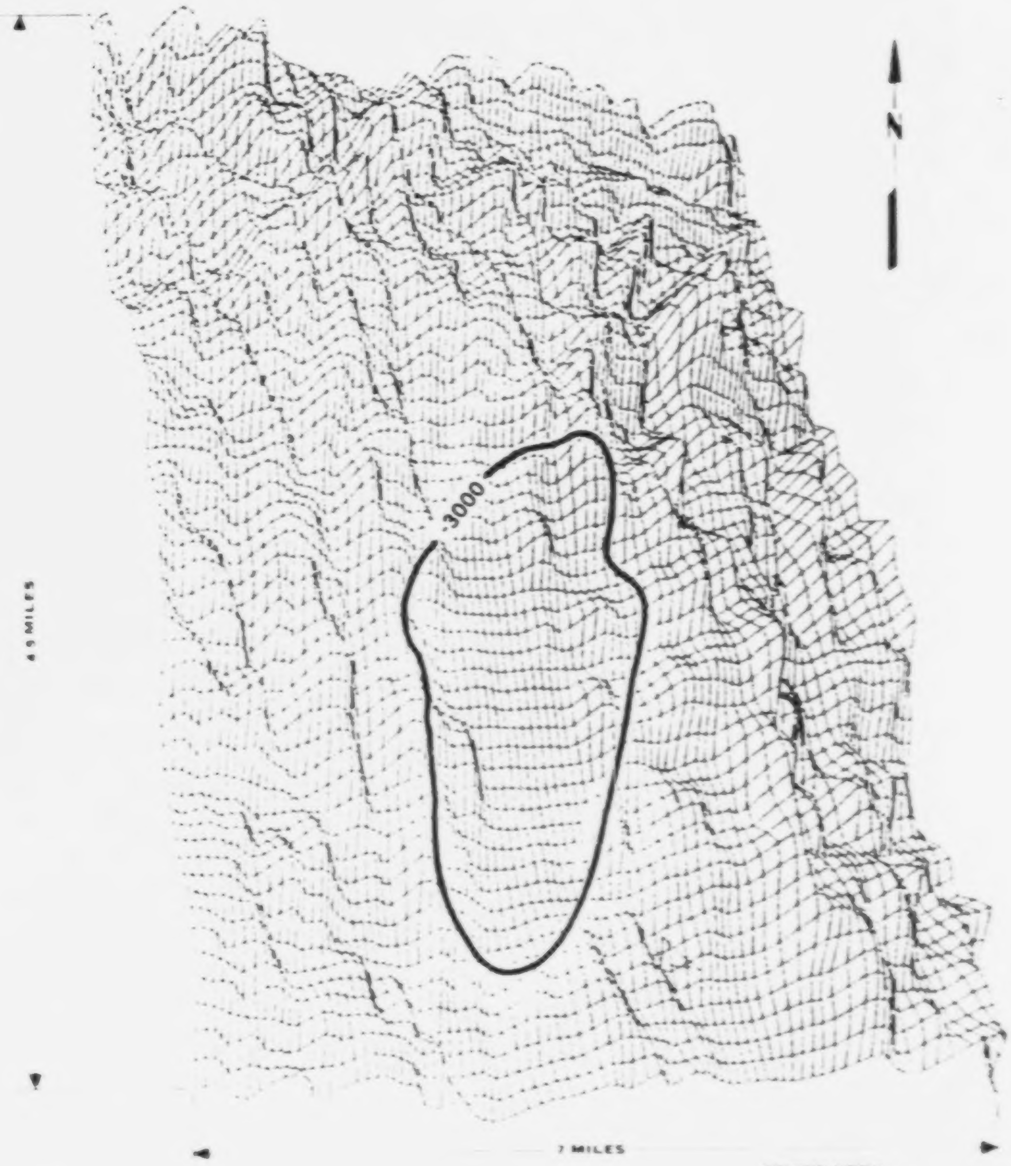
Drainage density was analyzed using contour maps of both drainage-link (channel segment between junctions) frequency and the ratio of exterior to interior drainage links (Figures 13-15 and 13-16). When these maps were compared to the outcrop pattern (Figure 13-12), it confirmed field observations that drainage is dominated by the physical properties of the exposed beds, as illustrated by the correspondence between drainage density and the outcrop pattern. The contours of drainage ratio show a decrease in fluvial activity over the dome, which is apparently related to lower relief as well as to localized aggradation by Cypress Creek.

Shallow borings, to depths of 82 meters (270 ft), and surface lithologic/geologic mapping indicate that the Hattiesburg and Citronelle Formations and Recent alluvium are present at the surface in the near-dome area (Figure 13-12). A few isolated and poorly developed terrace remnants were mapped to the south of the supradomal area within the limits of the present flood plain of Cypress Creek.

The Hattiesburg Formation is exposed over approximately one third of the near-dome area, principally in the northern and eastern portions. It generally exhibits more rugged topography than the Citronelle Formation. The Hattiesburg Formation is not exposed over the supradomal area (Figure 13-12).

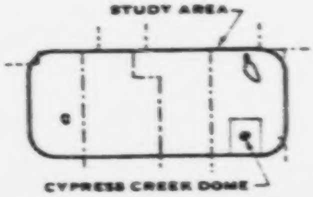
The Hattiesburg Formation consists of green to greenish-gray, massive, silty clays and fine sandy, silty clays with interbedded

AF 12338A


N
3000
4.9 MILES
7 MILES

LEGEND

— -3000 — LINE OF EQUAL ELEVATION OF SALT, IN FEET
DATUM IS MEAN SEA LEVEL.


STUDY AREA
CYPRESS CREEK DOME

PREPARED LDG DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED ______ DATE ______
APPROVED [illegible] DATE [illegible]
T-1268-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
THREE - DIMENSIONAL
TOPOGRAPHIC PROJECTION
JOB NO. MV 9600 FIGURE 13-13

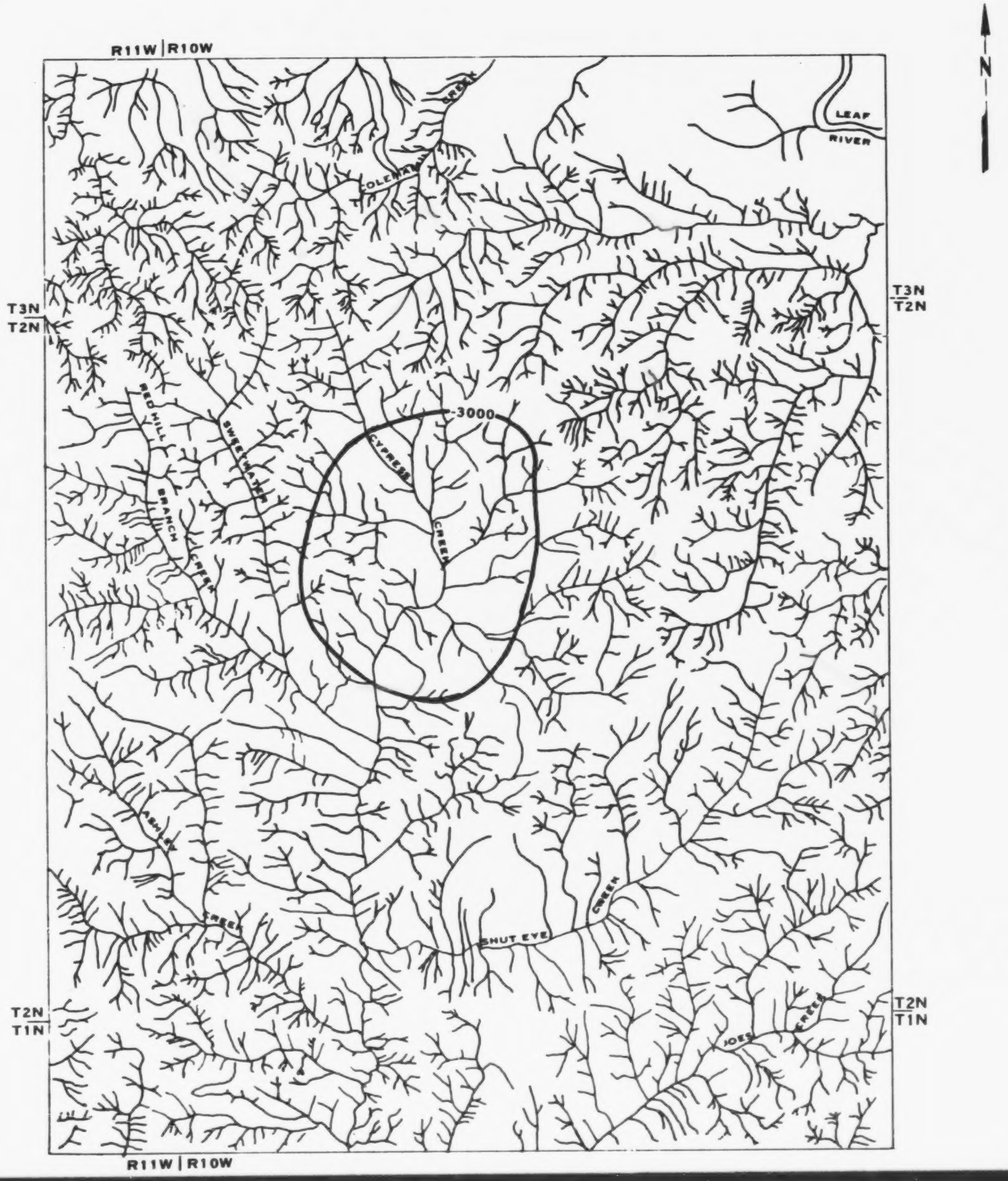
149 BEST DOCUMENT AVAILABLE

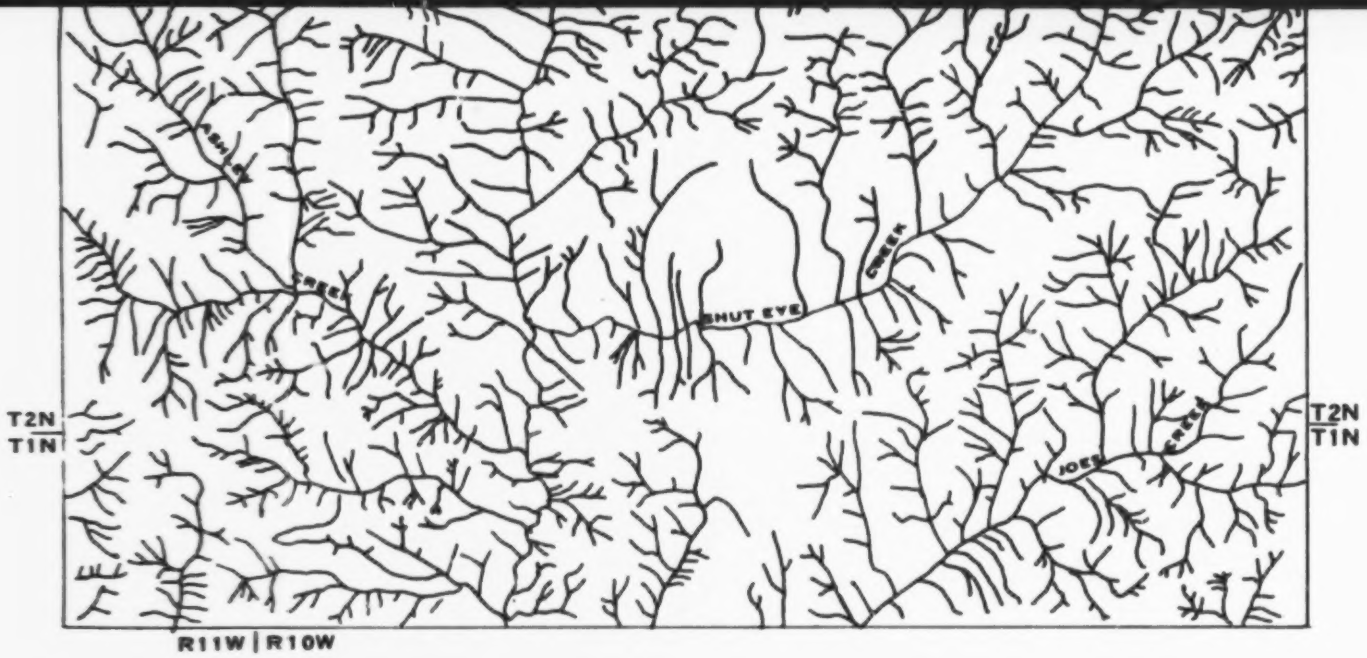
gray to brown, silty sands. A large sand body, apparently composed of channel sands, occurs within the Hattiesburg in the northeast quadrant of the near-dome area. Field mapping indicates that these channel sands erode easily at their outcrop by piping caused by ground-water infiltration which undermines the overlying sandy and silty clays. An excellent example of the gullying which results from this process is the westward-trending drainage course of an unnamed tributary of the Leaf River in Sections 35 and 36 of T3N, R10W in the northeastern portion of the near-dome area (Figure 13-1).

The Citronelle Formation, which caps most of the hills in the near-dome area, is found over the remainder of the near-dome area not occupied by Cypress Creek or its major tributaries. It consists of variegated gray, orange, and red variably silty and clayey sands and sandy, silty clays. Lenses of silty clays and clayey sands occur within the major sandy strata, as do occasional gravels of quartz and chert. The Citronelle sediments cover about half of the supradomal area and they are roughly bisected by the Recent alluvium beneath both the swamp and the flood plain of Cypress Creek.

Recent alluvium, consisting of gray to brown, laminated, silty fine sand and fine sandy, clayey silt mixed with variable amounts of organic material, occupies the flood plains of Cypress, Red Hill Branch, Ashley, Richland, Joes, and Shut Eye Creeks south of the dome. Alluvium occupies the broadened flood plain of Cypress Creek and the adjacent swamp in the supradomal area. The presence of this swamp suggests that dissolution of

[redacted]

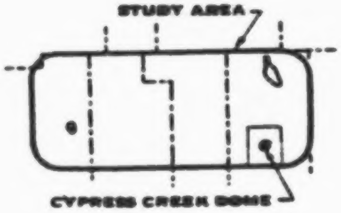

R11W | R10W
N
LEAF RIVER
COLEMAN
CREEK
T3N
T2N
T3N
T2N
RED HILL
BRANCH
CREEK
SWEETWATER
-3000
CYPRESS
CREEK
ASHLEY
CREEK
SHUT EYE
CREEK
JOES
CREEK
T2N
T1N
T2N
T1N
R11W | R10W


ASHLEY
CREEK
SHUT EYE
CREEK
JOES
CREEK
T2N
T1N
T2N
T1N
R11W | R10W

LEGEND

—— -3000 —— LINE OF EQUAL ELEVATION OF SALT IN FEET. DATUM IS MEAN SEA LEVEL.

DRAINAGE PATTERN


STUDY AREA
CYPRESS CREEK DOME

1
0
1 MILES
1
0
1
KILOMETERS

BEST DOCUMENT AVAILABLE

FIGURE 13-14

PREPARED J.DG DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED DATE 8/15/80

T-1269-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

CYPRESS CREEK DOME

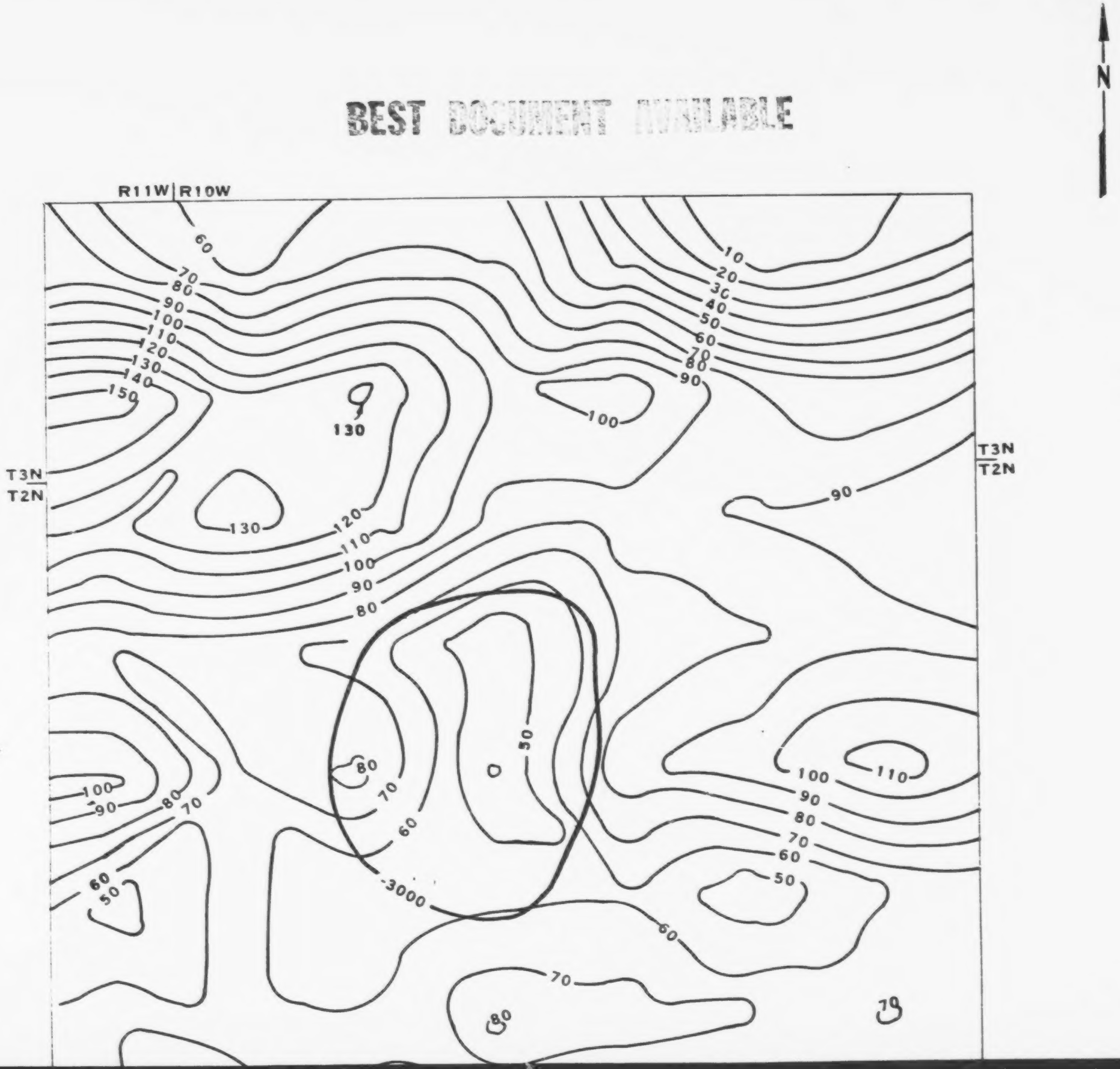
DRAINAGE NETWORK

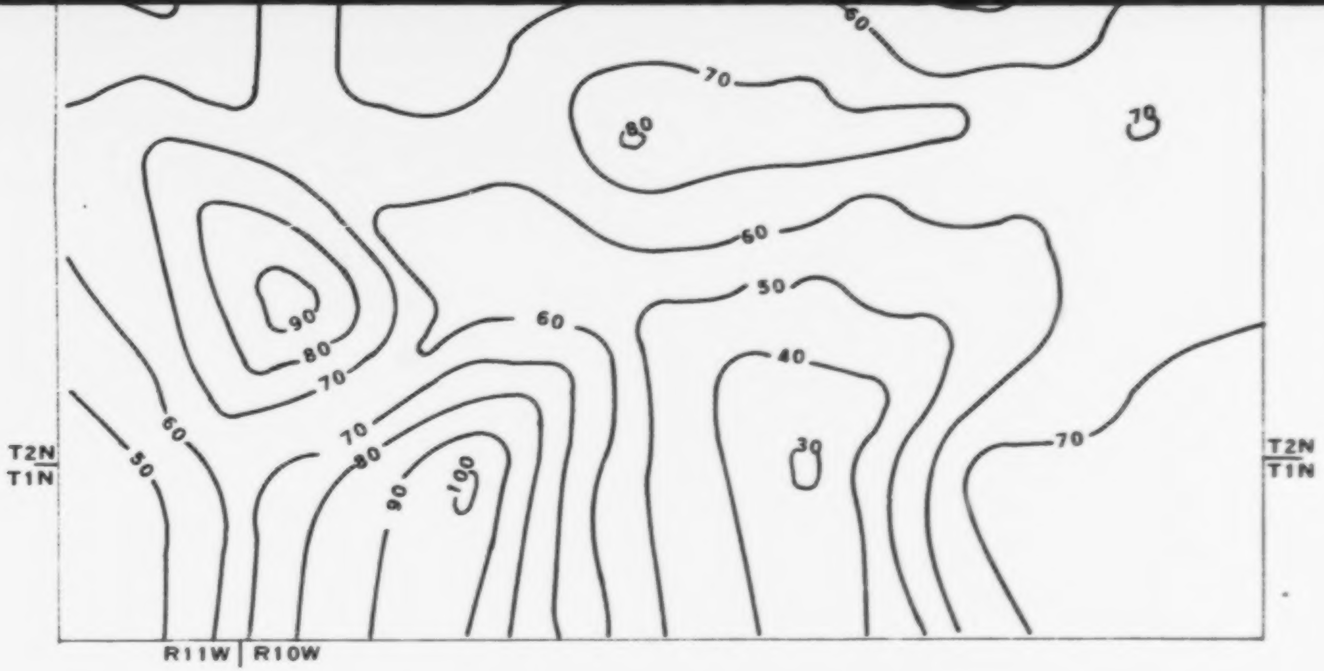
JOB NO. MV 9600

FIGURE 13-14

151-A

BEST DOCUMENT AVAILABLE


N
R11W
R10W
T3N
T2N
T3N
T2N
60
70
80
90
100
110
120
130
140
150
9
130
130
120
110
100
90
80
10
20
30
40
50
60
70
80
90
100
90
100
90
80
70
60
50
80
70
60
-3000
50
0
100
110
100
90
80
70
60
50
60
70
80
79



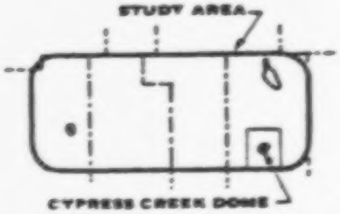
60
70
80
70
60
50
40
30
60
90
80
70
60
50
70
80
90
100
70
T2N
T1N
T2N
T1N
R11W
R10W

1521

LEGEND

—— -3000 —— LINE OF EQUAL ELEVATION OF SALT, IN FEET. DATUM IS MEAN SEA LEVEL.

——70—— LINE OF EQUAL NUMBER OF EXTERIOR/INTERIOR DRAINAGE LINKS PER SQUARE MILE. INTERVAL 10 LINKS.



STUDY AREA
CYPRESS CREEK DOME

1
0
1
MILES
1
0
1
KILOMETERS

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1270-1

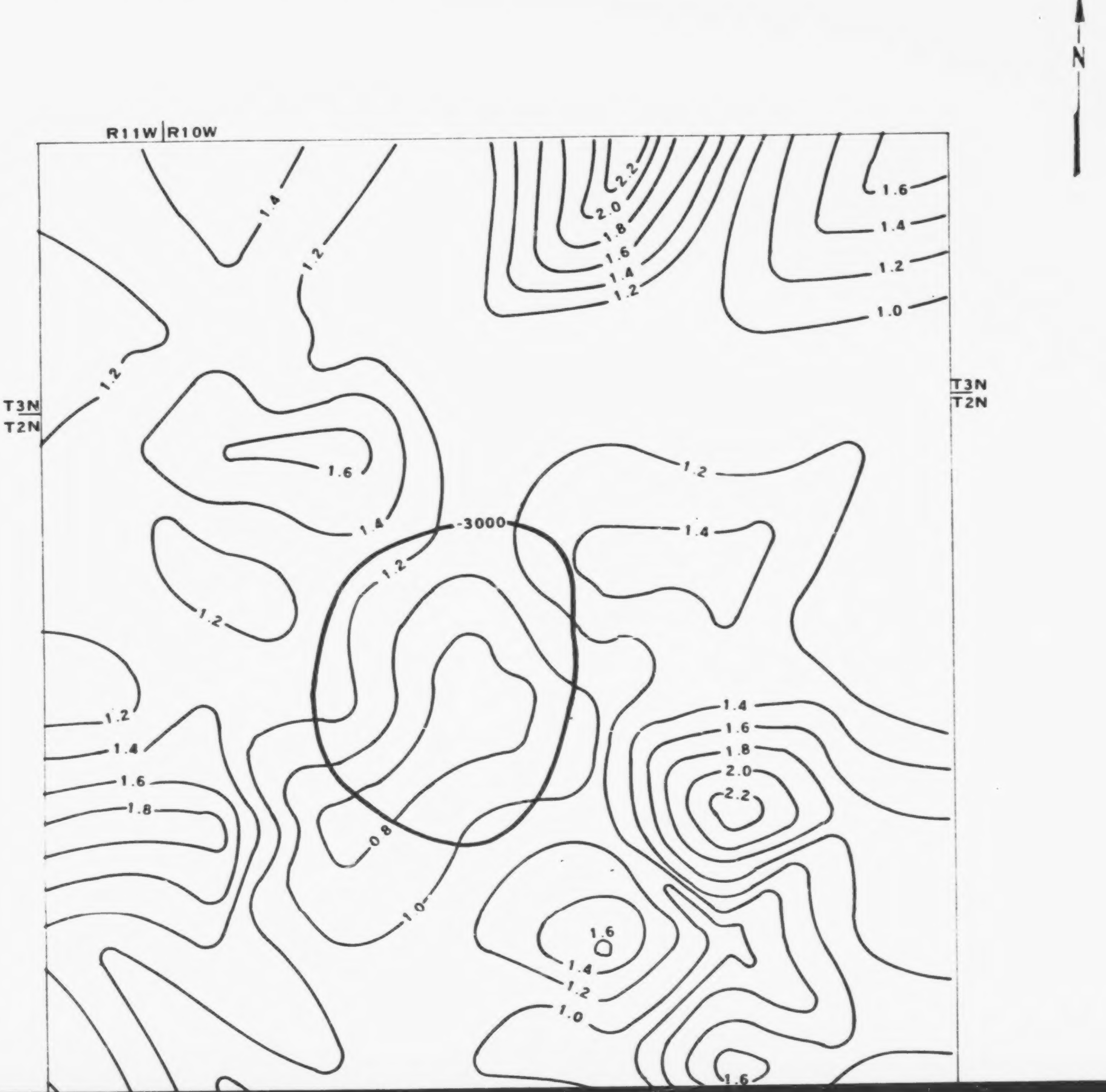
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

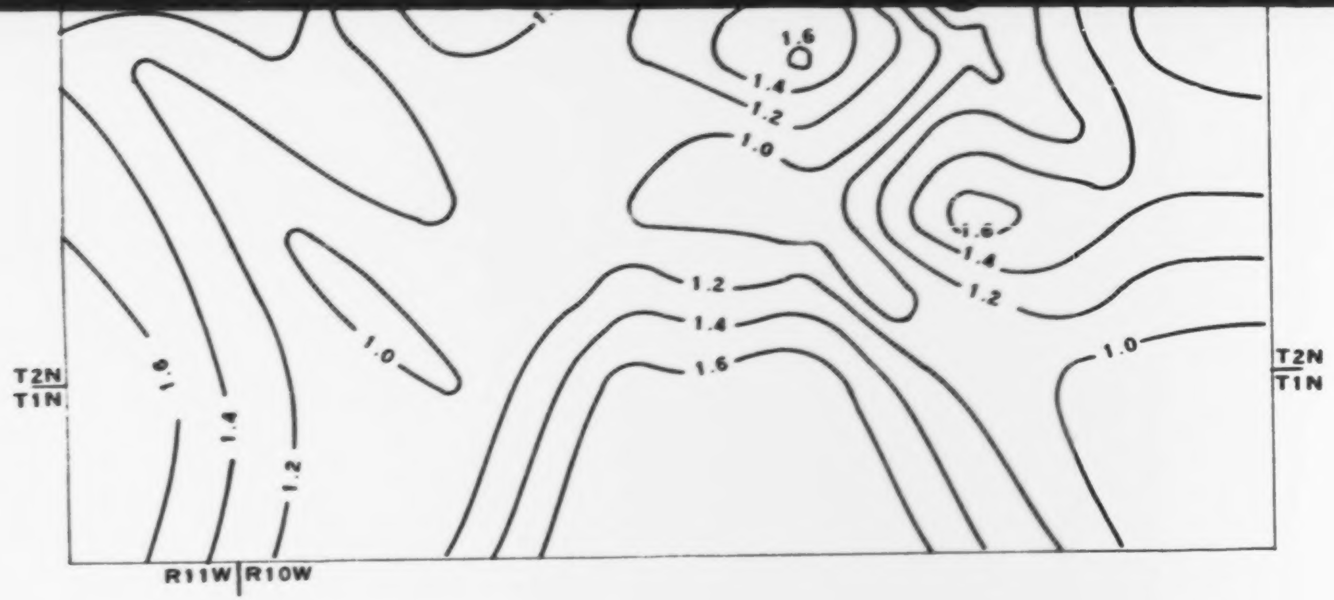
MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
ISOLINES OF EXTERIOR/INTERIOR DRAINAGE LINK FREQUENCY

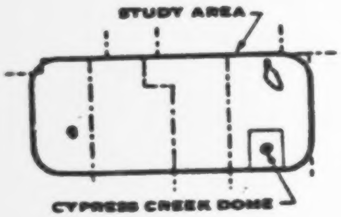
JOB NO. MV 9600
FIGURE 13-15

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE


N
R11W
R10W
T3N
T2N
T3N
T2N
1.4
1.2
1.2
2.2
2.0
1.8
1.6
1.4
1.2
1.6
1.4
1.2
1.0
1.6
1.4
1.2
1.2
-3000
1.2
1.4
1.2
1.2
1.4
1.6
1.8
0.8
1.0
1.4
1.6
1.8
2.0
2.2
1.6
1.4
1.2
1.0
1.6


1.
1.6
1.4
1.2
1.0
1.6
1.4
1.2
1.2
1.4
1.6
1.0
1.0
1.6
1.4
1.2
T2N
T1N
T2N
T1N
R11W
R10W


STUDY AREA
CYPRESS CREEK DOME

LEGEND

— -3000 — LINE OF EQUAL ELEVATION OF SALT IN FEET DATUM IS MEAN SEA LEVEL.

—1.0— LINE OF EQUAL RATIO OF EXTERIOR/INTERIOR DRAINAGE LINKS PER SQUARE MILE. INTERVAL 0.2 UNITS.

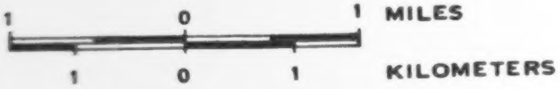

1
0
1
MILES
1
0
1
KILOMETERS

FIGURE 13-16

PREPARED	J.D.G	DATE	5-30-80
REVISED	[illegible]	DATE	[illegible]
REVISED		DATE	
APPROVED	[illegible]	DATE	8/15/80

T-1271-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

CYPRESS CREEK DOME
ISOLINES OF DRAINAGE RATIO

JOB NO. MV9600

FIGURE 13-16

BEST DOCUMENT AVAILABLE

the salt stock or subsidence of a graben structure over the dome may have occurred in the recent geologic past, and that subsequent subsidence of the overlying strata formed this topographic low. This topographic depression is discussed in detail in Section 13.1.2.3.

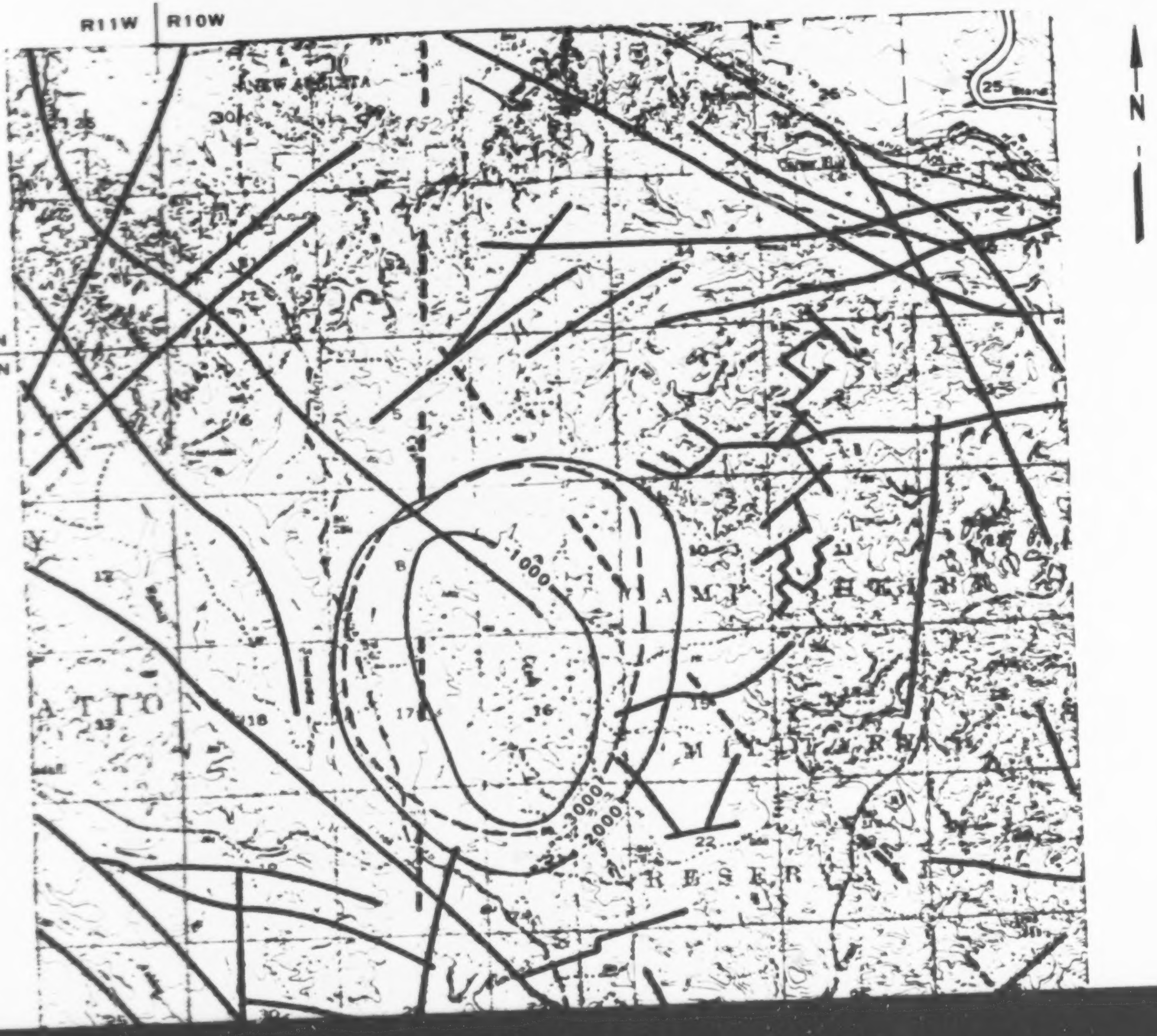
In the near-dome area two lineaments were observed on Landsat imagery (Figure 13-17). One of the lineaments trends northward and it is coincident with the flood plain of Cypress Creek; the other trends northwesterly and its origin is unclear. The numerous lineaments detected on color infrared imagery exhibit a bimodal orientation, generally trending northwesterly and northeasterly. Most long lineaments observed on color infrared photographs correspond to local topographic relief and drainage features. Overall lineament density in the near-dome area is generally somewhat less than that of the study area as a whole (Figure 12-8). A high density of lineaments and intersections does occur in the northeast portion of the near-dome area. These lineaments correspond to drainage features resulting from rapid erosion of channel sands in the Hattiesburg Formation. Lineaments within the near-dome area do not appear to be either concentrated or oriented so as to suggest that the supradomal area is anomalous in any way that may be indicative of instability during the recent geologic past.

13.1.2.2 Stratigraphy: The stratigraphic section investigated in the Cypress Creek Dome area includes Paleocene and younger units (Table 13-1). Figure 13-7 is a geologic cross section which illustrates the relationship of the stratigraphic units to each other and to the dome. A map showing the location of the line of section is presented in Figure 13-5.

Lithologic descriptions and stratigraphic correlations of beds to depths of 1,250 meters (4,100 ft) are based on petrologic and paleontologic analyses of drill cuttings and sidewall cores and interpretation of geophysical logs obtained from wells drilled during the Area Characterization field program. Well information is presented in the Mississippi Study Area Appendix. Geophysical logs obtained from previously drilled wells were used for lithologic descriptions and stratigraphic correlations to supplement data from the Area Characterization wells (Figure 13-3 and Table 12-2). Three high-resolution seismic reflection lines were used to determine the attitude of the near-dome beds to about -914 meters (-3,000 ft) MSL (Figures 13-9 through 13-11).

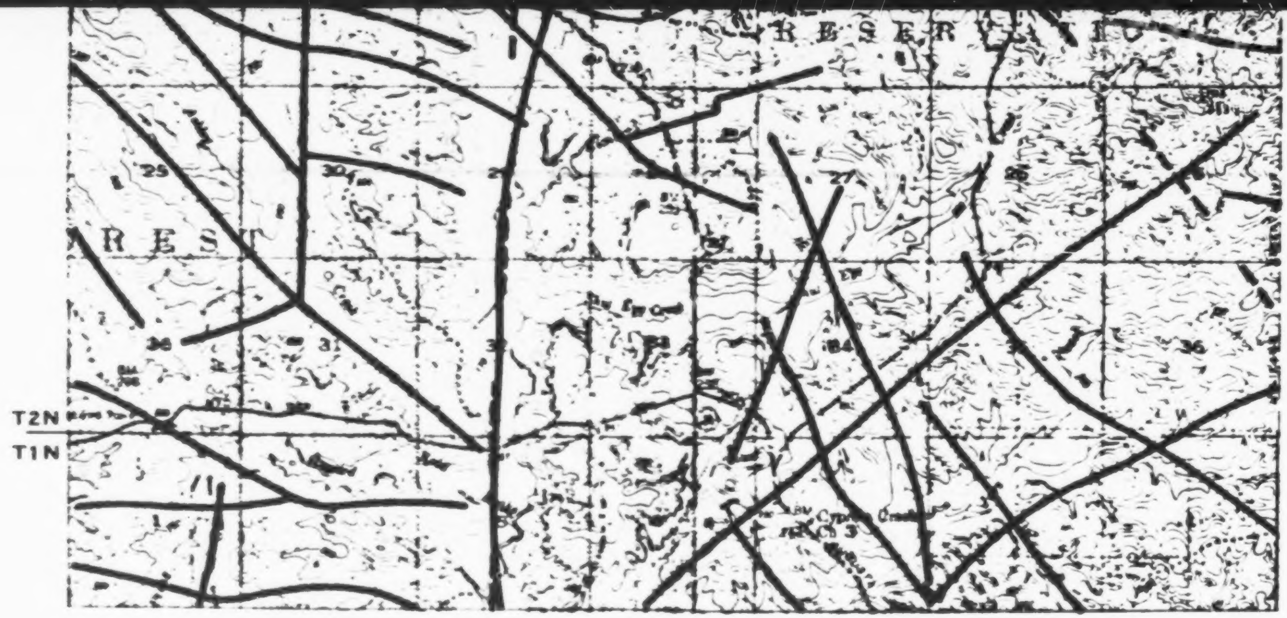
Lithologic descriptions and stratigraphic correlations of the surficial units are primarily based upon data from fifty Area Characterization shallow borings. Shallow boring information is presented in the Mississippi Study Area Appendix. These borings were drilled under LETCo direction to depths ranging from 5 to 82 meters (15 to 270 ft). Other data sources used include field geologic maps, ground-level resistivity horizontal profiles and vertical soundings, and mineralogical studies of selected split-spoon samples (Figures 13-2 and 13-18).

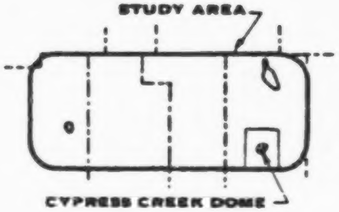
13.1.2.2.1 Stratigraphic Analysis - Formations in the Cypress Creek Dome area are generally similar in lithology to


R11W
R10W
T3N
T2N
N
NEW AUGUSTA
1000
2000
3000
A T T I O
RESER

BEST DOCUMENT AVAILABLE

FIGURE 13-17


RESERV
REST
T2N
T1N
25
30
27
26
36
31
34
35
Cypress Creek


STUDY AREA
CYPRESS CREEK DOME

LEGEND

— -1000 — LINE OF EQUAL ELEVATION OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL 1000 FEET

——— LINEAMENT FROM HIGH ALTITUDE COLOR INFRARED IMAGERY.

— — — — INDEFINITE LINEAMENT FROM LANDSAT IMAGERY

1 0 1 MILES

1 0 1 KILOMETERS

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL.

BASE FROM U.S. GEOLOGICAL SURVEY
1:62,500 QUADRANGLE.

PREPARED JDG DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1272-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

CYPRESS CREEK DOME

LINEAMENT MAP

JOB NO. MV 9600

FIGURE 13-17

BEST DOCUMENT AVAILABLE

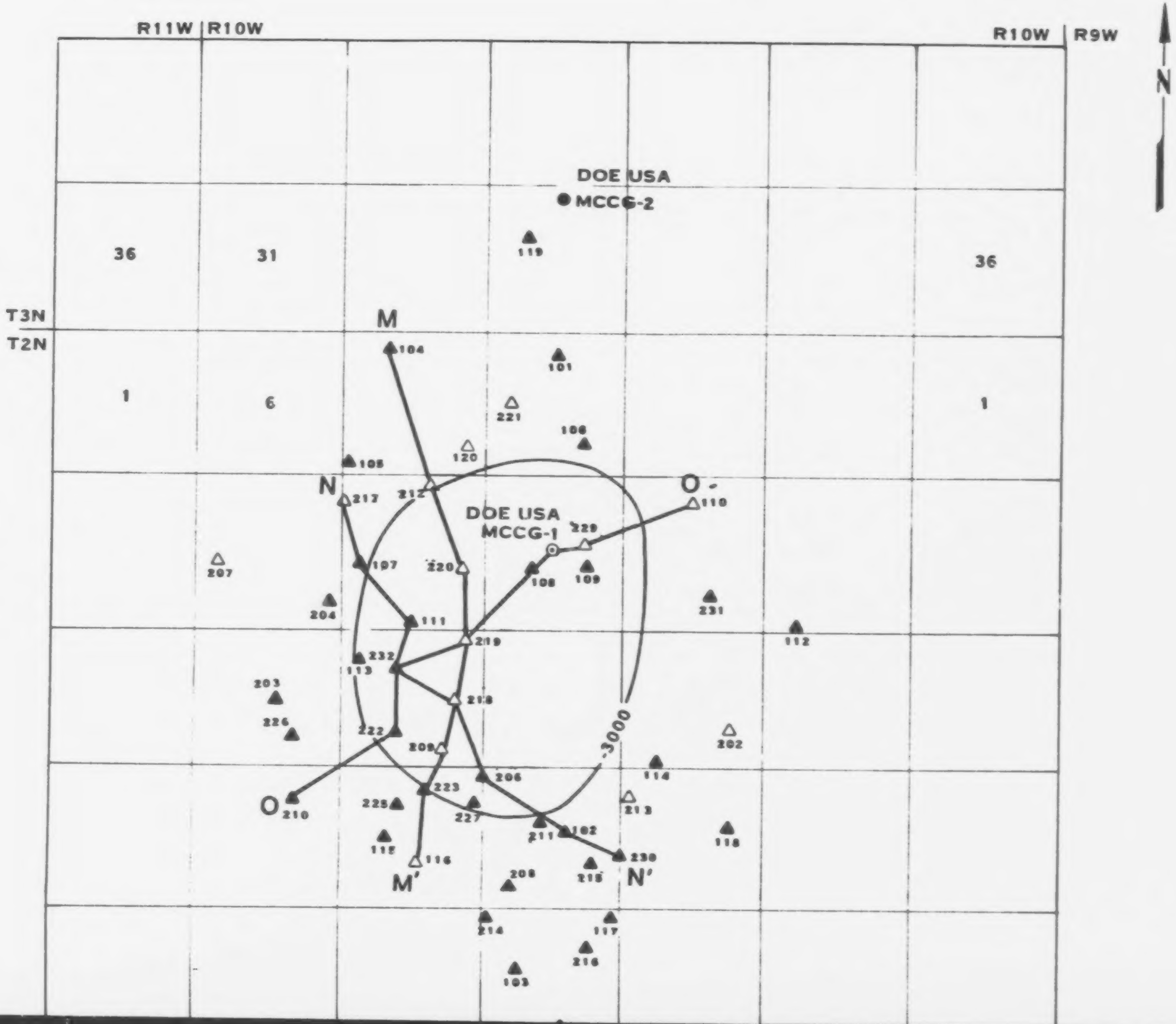
AF 12338A

SYSTEM	SERIES	GROUP OR STAGE	FORMATION	AGE MYBP	THICKNESS FEET STUDY AREA	THICKNESS FEET CYPRESS CREEK DOME	CYPRESS CREEK DOME LITHOLOGY
QUATERNARY	RECENT		ALLUVIUM		0 – 125	0 – 50	Interbedded very fine to fine grained silty sands, clays, and silts. A few terrace remnants lithology unknown, occur in Recent alluvial floodplains.
	PLIO PLEISTOCENE		CITRONELLE	1.8	0 – 215	0 – 185	Fine to coarse grained, silty sands, gravelly sands, clayey sands and clays.
TERTIARY	MIOCENE		HATTIESBURG AND CATAHOULA UNDIFF	22.5	849 - 1991	1395 - 1991	Interbedded very fine to coarse grained, locally limy sands, highly plastic and locally sandy partially bentonitic clays, chalky limestones, and, occasionally, lignites. Includes the Heterostegina zone; a chalky limestone and fine to coarse grained sand unit.
	OLIGOCENE		CHICKASAWHAY		46 - 215	114 - 215	Clay, very fine to medium grained sands and chalky, locally calcarenitic, and locally very porous limestones.
		VICKSBURG	BUCATUNNA		11 – 91	50 - 91	Very fine to coarse grained locally lignitic quartz sands and lignitic clays with traces of limestone
			VICKSBURG LIMESTONES UNDIFF		61 - 240	161 - 218	Calcarenitic, locally bioclastic, glauconitic limestones, occasionally interbedded with minor sand, clay, mudstone, and dolomite
			RED BLUFF	36	15 – 123	98 - 123	Interbedded limy clays, very fine to medium grained sands, and calcarenitic, locally argillaceous limestones
	EOCENE	JACKSON	YAZOO		113 - 330	135 - 192	Limy, slightly silty clays with fine and medium grained, limy, glauconitic sands or calcareous claystone with variable amounts of limestone, clay, mudstone, and lignite
			MOODYS BRANCH	42	10 - 37	25 - 37	Interbedded fine and very fine grained sands, chalky, sometimes glauconitic limestones and occasional silty, limy mudstones.
		CLAIBORNE	COCKFIELD		76 - 295	180 - 295	Interbedded clays, very fine to medium grained sands, and minor limestones and mudstones to interbedded sandy, abundantly glauconitic limestones, lignites and fine to coarse grained sands.
			COOK MOUNTAIN	44.5	112 - 260	177 – 260	Occasionally sandy, chalky, calcarenitic limestones interbedded with variable amounts of sand, clay, mudstone and shale.
			KOSCIUSKO (SPARTA)	48	121 370	140 - 152	Interbedded bentonitic, non-calcareous, silty clays and fine and very fine grained glauconitic, argillaceous, partially limy sands to interbedded limestones and glauconitic shales with thin, fine to coarse grained sands in the lower portion
			ZILPHA		45 - 220	45 - 85	Glauconitic clay and shale, silty, limy mudstone and limestone
			WINONA		22 - 62	33 - 50	Interbedded crystalline to microcrystalline limestones and very fine to coarse grained glauconitic, sometimes limy sands, locally interbedded with clay
			TALLAHATTA	50	127 - 500	395 - 500	Clays, limy shales, silty mudstones and microcrystalline, locally sandy, glauconitic limestones.
		WILCOX	WILCOX GROUP UNDIFF	53.5	1865 - 4955	2800 - 4955	Interbedded sands and clays of unknown induration
	PALEOCENE	MIDWAY	PORTERS CREEK		468 - 1195	940 - 1020	Clays underlain by a sand and clay unit, all of unknown induration
			CLAYTON		0 - 37	15 – 16	Argillaceous limestones

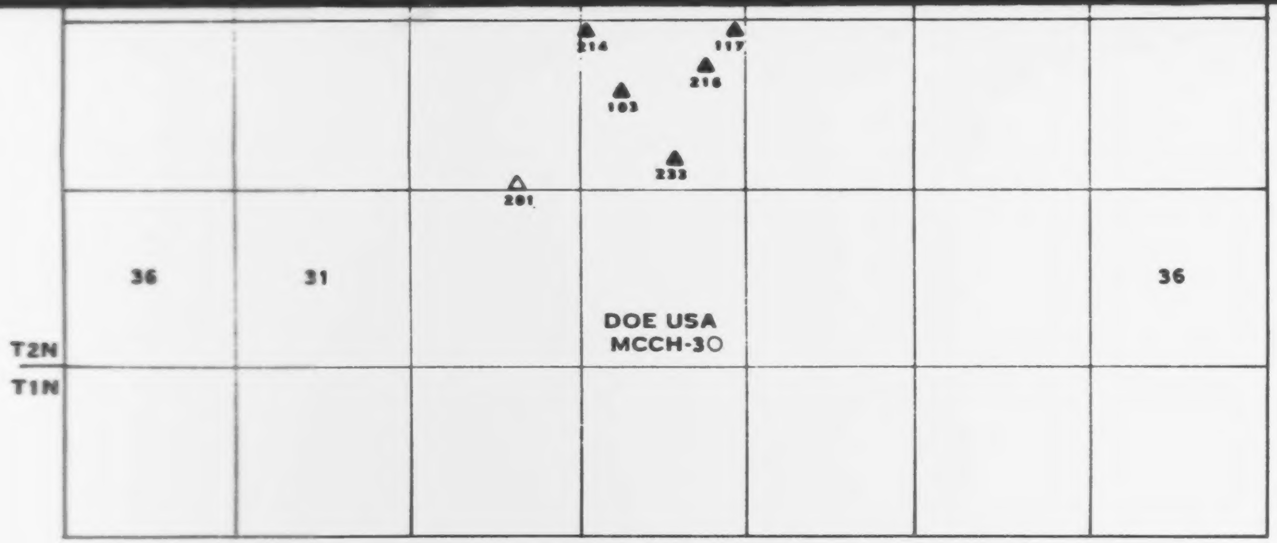
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
STRATIGRAPHIC CHART

JOB NO MV9600 TABLE 13-1


R11W
R10W
R10W
R9W
N
T3N
T2N
36
31
36
1
6
1
DOE USA
MCCG-2
DOE USA
MCCG-1
M
M'
N
N'
O
O'
-3000
119
104
101
221
106
120
105
217
212
110
229
107
220
108
109
207
204
111
231
112
219
232
113
203
218
226
222
202
209
114
206
223
225
213
210
227
211
102
118
115
116
230
215
208
214
117
216
103

BEST DOCUMENT AVAILABLE


214
117
216
103
233
201
36
31
36
DOE USA
MCCH-3○
T2N
T1N

LEGEND

○ AREA CHARACTERIZATION HYDROLOGIC BORING

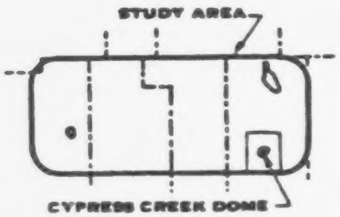
● AREA CHARACTERIZATION GELOLGIC BORING

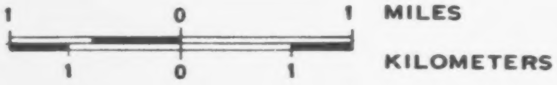
◎ AREA CHARACTERIZATION SALT CORE BORING

101▲ AREA CHARACTERIZATION SHALLOW BORING

118△ AREA CHARACTERIZATION SHALLOW BORING LOCATION NOT SURVEYED

—-3000— LINE OF EQUAL ELEVATION OF SALT IN FEET. DATUM IS MEAN SEA LEVEL.


STUDY AREA
CYPRESS CREEK DOME


1
0
1
MILES
1
0
1
KILOMETERS

PREPARED
REVISED
REVISED
APPROVED

DATE [illegible]
DATE [illegible]
DATE
DATE [illegible]

T-1401-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
LOCATION MAP
SHALLOW GEOLOGIC SECTIONS
M-M', N-N' AND O-O'

JOB NO. MV9600

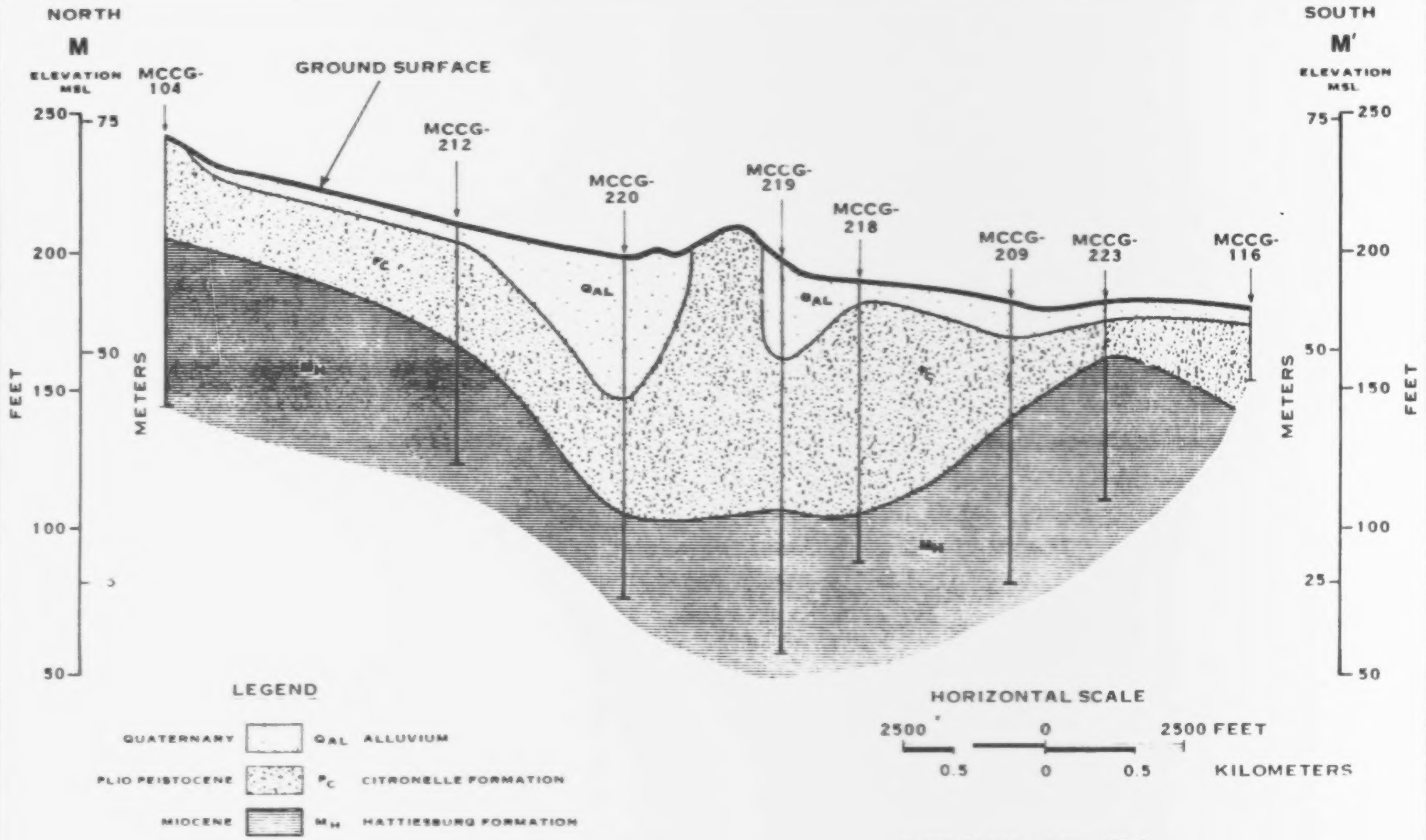
FIGURE 13-18

FIGURE 13-18

BEST DOCUMENT AVAILABLE

corresponding units of the study area described in Section 12.2.2. Lithologic descriptions of the formations, prepared utilizing well cuttings in the near-dome area, are included in the Cypress Creek Dome Stratigraphic chart (Table 13-1). The greatest variations between the local and regional lithologies appear to be in the Tallahatta, Winona, and Moodys Branch Formations, and in the Cockfield, Yazoo, and Chickasawhay Formations. The Winona, Cockfield, Yazoo and Chickasawhay Formations contain more sand in the Cypress Creek Dome area than is indicated in the regional descriptions. Except for the Winona, the sand is described as fine or very fine to medium-grained. The sand in the Winona Formation varies from very fine to coarse-grained. The presence of sand in these formations is consistent with their depositional environments, which are shallow or very shallow marine. None of these formations overlie the supradomal area.

The Perry Basin, as described in Section 12.2.3.2 and as shown in Figures 12-13 through 12-22, represents a Tertiary depocenter in the Mississippi Salt Basin. The sedimentary sequence in the salt basin is about 8,230 meters (27,000 ft) thick and it varies in lithology. The dip of these units steepens toward the center of the basin. The proximity of the center of the Perry Basin to the southern flank of Cypress Creek Dome accounts for the large differences in physical characteristics of some of the units surrounding the dome. For example, Cenozoic formation thicknesses are generally greater south of the dome than north of it, and these greater thicknesses are often in the upper range of thicknesses for the study area.


NORTH
M
ELEVATION MSL
SOUTH
M'
ELEVATION MSL
GROUND SURFACE
MCCG-104
MCCG-212
MCCG-220
MCCG-219
MCCG-218
MCCG-209
MCCG-223
MCCG-116
FEET
METERS
250
200
150
100
50
75
50
25
P_C
Q_{AL}
M_H
LEGEND
QUATERNARY Q_{AL} ALLUVIUM
PLIO PEISTOCENE P_C CITRONELLE FORMATION
MIOCENE M_H HATTIESBURG FORMATION
HORIZONTAL SCALE
2500 0 2500 FEET
0.5 0 0.5 KILOMETERS

VERTICAL EXAGGERATION 50X

SEE FIGURE 13.18 FOR LOCATION

PREPARED JDG DATE 12-4-81
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED DG DATE [illegible]

T-1403-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

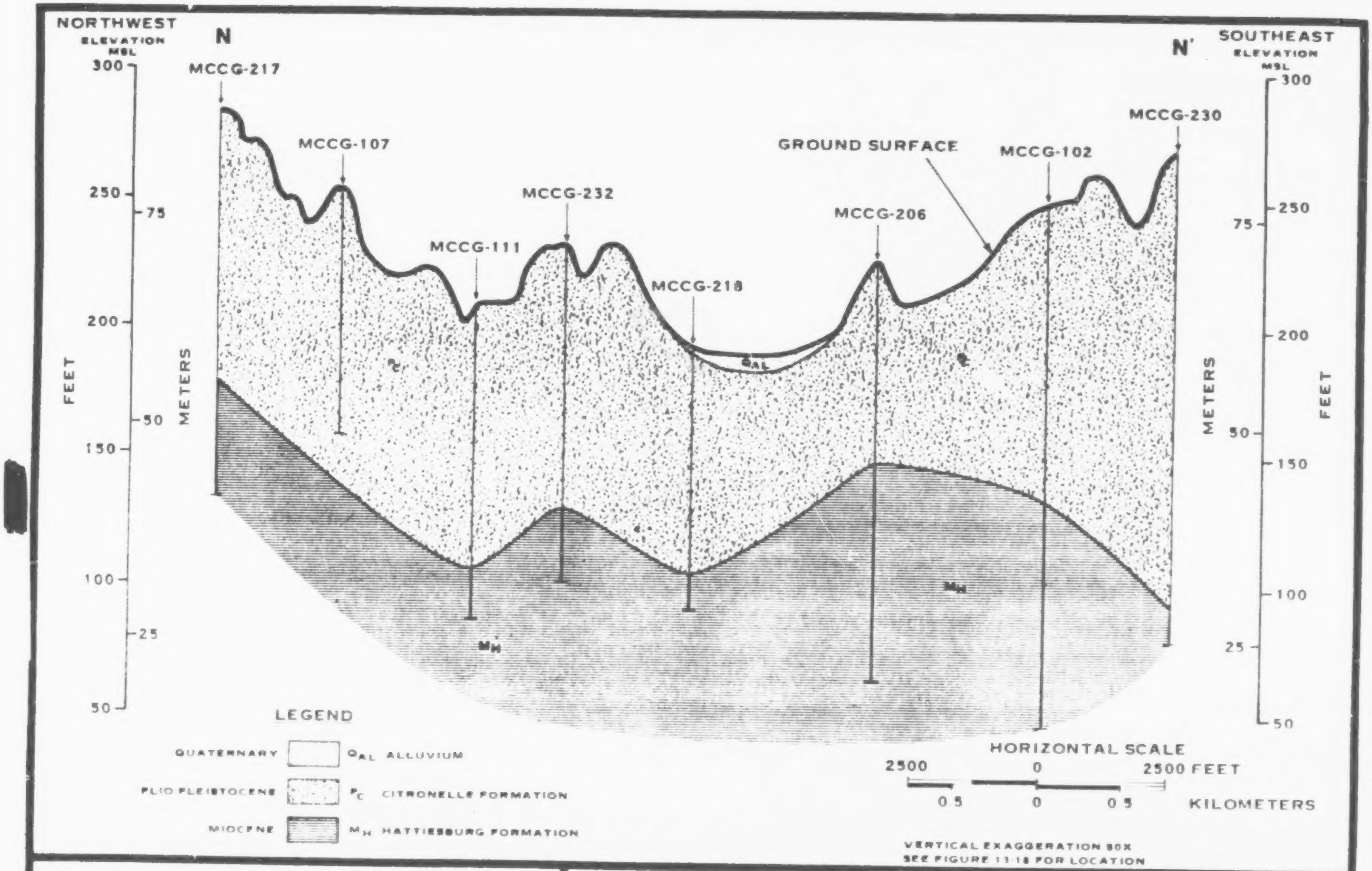
MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
SHALLOW GEOLOGIC SECTION M-M'

JOB NO MV9600

FIGURE 13-19

FIGURE 13-19

BEST DOCUMENT AVAILABLE


NORTHWEST
ELEVATION MSL
N
N'
SOUTHEAST
ELEVATION MSL
300
250
200
150
100
50
75
50
25
FEET
METERS
MCCG-217
MCCG-107
MCCG-232
MCCG-111
MCCG-218
MCCG-206
GROUND SURFACE
MCCG-102
MCCG-230
Q_{AL}
P_C
M_H
LEGEND
QUATERNARY
Q_{AL} ALLUVIUM
PLIO PLEISTOCENE
P_C CITRONELLE FORMATION
MIOCENE
M_H HATTIESBURG FORMATION
HORIZONTAL SCALE
2500
0
2500 FEET
0.5
0
0.5
KILOMETERS
VERTICAL EXAGGERATION 80X
SEE FIGURE 13-18 FOR LOCATION

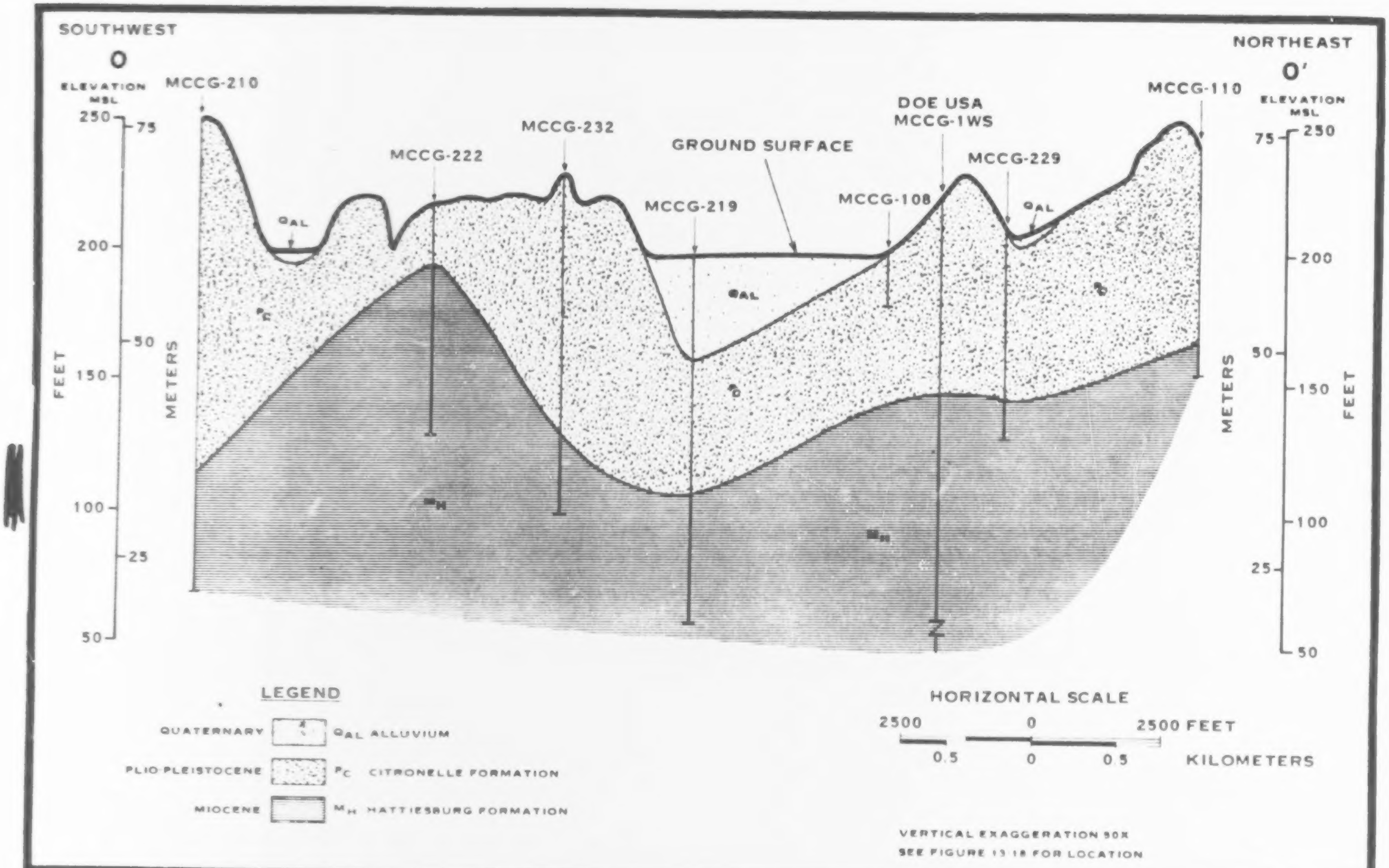
PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED C.P. DATE 12/4/81
T-1404-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
SHALLOW GEOLOGIC SECTION N-N'

JOB NO MV9600
FIGURE 13-20

BEST DOCUMENT AVAILABLE


SOUTHWEST
O
ELEVATION MSL
NORTHEAST
O'
ELEVATION MSL
MCCG-210
MCCG-222
MCCG-232
GROUND SURFACE
MCCG-219
MCCG-108
DOE USA MCCG-1WS
MCCG-229
MCCG-110
Q_{AL}
P_C
M_H
FEET
METERS
250
200
150
100
50
75
50
25
LEGEND
QUATERNARY Q_{AL} ALLUVIUM
PLIO-PLEISTOCENE P_C CITRONELLE FORMATION
MIOCENE M_H HATTIESBURG FORMATION
HORIZONTAL SCALE
2500 0 2500 FEET
0.5 0 0.5 KILOMETERS
VERTICAL EXAGGERATION 50X
SEE FIGURE 13-18 FOR LOCATION

PREPARED JDG DATE 12-4-81
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED DATE 12/7/81
T-1405-1

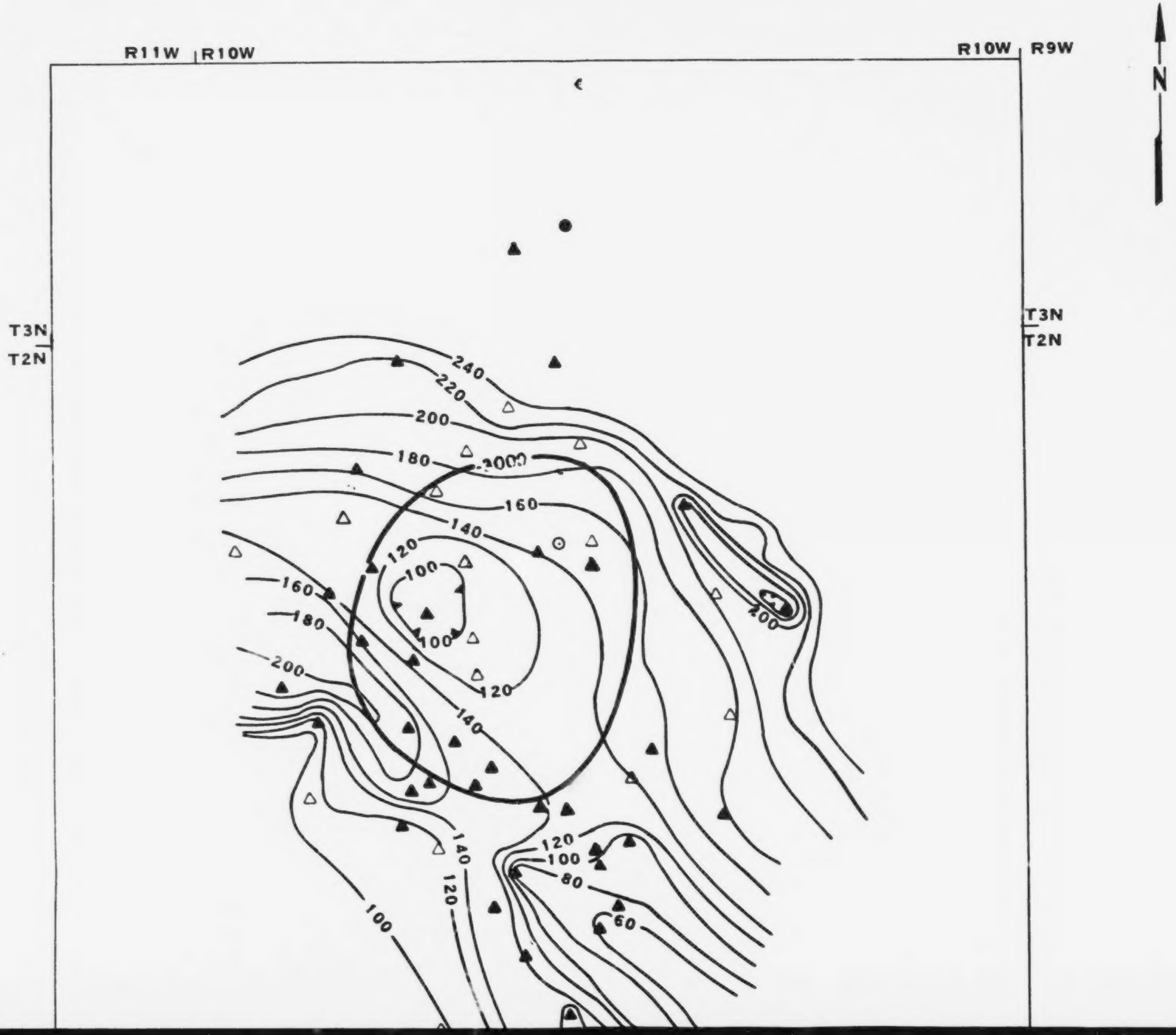
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

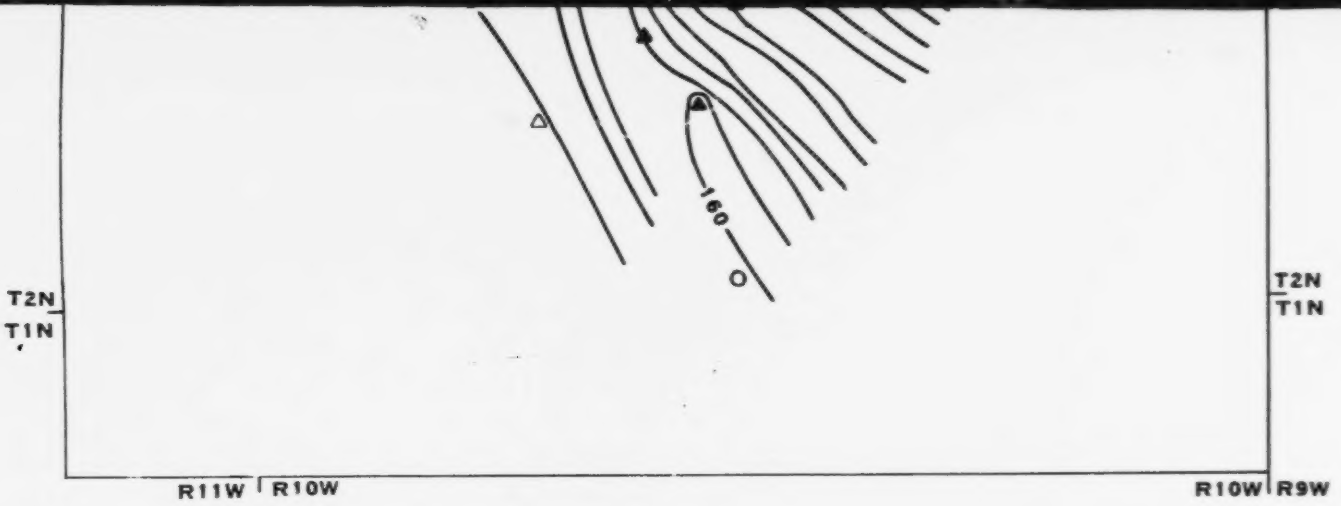
MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME
SHALLOW GEOLOGIC SECTION O-O'

JOB NO. MV9800 FIGURE 13-21

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

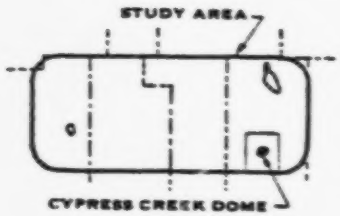

R11W
R10W
R10W
R9W
N
T3N
T2N
T3N
T2N
240
220
200
180
200
160
140
120
100
100
160
180
200
120
140
200
140
120
100
80
60
100
120
140


160
T2N
T1N
T2N
T1N
R11W
R10W
R10W
R9W

LEGEND

- ○ AREA CHARACTERIZATION HYDROLOGIC BORING
- ● AREA CHARACTERIZATION GEOLOGIC BORING
- ⊙ AREA CHARACTERIZATION SALT CORE BORING
- ▲ AREA CHARACTERIZATION SHALLOW BORING
- △ AREA CHARACTERIZATION SHALLOW BORING LOCATION NOT SURVEYED
- —3000— LINE OF EQUAL ELEVATION OF SALT, IN FEET. DATUM IS MEAN SEA LEVEL.
- —100— STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF HATTIESBURG FORMATION. DATUM IS MEAN SEA LEVEL.

1
0
1
MILES
1
0
1
KILOMETERS


STUDY AREA
CYPRESS CREEK DOME

163A

PREPARED	J.D.G.	DATE	12-4-81
REVISED		DATE	
REVISED		DATE	
APPROVED	[illegible]	DATE	[illegible]

T-1402-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOME

STRUCTURE CONTOUR MAP
TOP OF HATTIESBURG FORMATION

JOB NO. MV9600 FIGURE 13-22

FIGURE 13-22

BEST DOCUMENT AVAILABLE

The Wilcox Group, the Porters Creek, Tallahatta, Cook Mountain, Cockfield, Moodys Branch, and Red Bluff Formations, and the undifferentiated Vicksburg Limestone unit have greater than normal thicknesses in the study area. The Zilpha Formation is much thinner in the Cypress Creek Dome area than in other parts of the study area, possibly because of domal growth during its deposition. Variations in the rate of domal growth, coincident with subsidence of the Perry Basin, are apparently responsible for the corresponding variations in formation thicknesses in the near-dome area.

The Chickasawhay and Bucatunna Formations develop a maximum (known) thickness north of Cypress Creek Dome. Subsidence resulting from salt flowage into the dome may have produced flanking basins or rim synclines other than the Perry Basin, which is discussed as a salt withdrawal basin in Section 12.2.3.2. Thick accumulations of sediments were deposited in these basins. The sparse data make it difficult to distinguish between a possible rim syncline north of the dome and broad subsidence in the surrounding area of the Perry Basin.

The Kosciusko and Cockfield Formations are thickest south of the dome. These formations also vary laterally from sands and clays north of the dome to primarily limestones south of the dome. In the near-dome area the formations are lithologically similar to those of the general region except for the Tallahatta, Winona, and Moodys Branch Formations, which contain more lime and less sand. Subsidence of the Perry Basin, rather than local influences, may have caused slight variations in depositional environments which resulted in the lithologic changes observed in these formations near the dome.

13.1.2.2.2 Stratigraphy of Surficial Units - The surficial geologic units which are exposed in the Cypress Creek Dome area include the Hattiesburg and Citronelle Formations and Quaternary alluvium. Isolated remnants of terrace surfaces occur in the alluvium, principally within the flood plain of Cypress Creek.

These units were investigated by utilizing field mapping, shallow geologic borings, geophysical logs, electrical resistivity surveying, hand sample collection, and various analyses of the collected samples. Field mapping was initiated by Dr. R. L. Bowen of the University of Southern Mississippi (Bowen, 1979), and completed by LETCo, resulting in the geologic map presented in Figure 13-12.

The Hattiesburg Formation consists primarily of greenish-gray, silty, fine sandy clay and interbedded gray, silty, fine sand and occasional large sand bodies, presumably channel sands. The formation weathers to a grayish-tan, nodular, silty, fine sandy clay. Split-spoon samples from borings do not commonly show bedding, and most outcrops appear massive, displaying few primary structures. However, some outcrops of the Hattiesburg in the study area do show nearly horizontal bedding, with beds less than 25 mm (1 in) to 1.5 meters (5 ft) thick.

The Citronelle Formation consists primarily of reddish-brown and yellowish-brown, silty, coarse to fine-grain sand, with lenses and interbeds of silt, silty clay and clay, and occasional interbedded fine to coarse-grain gravelly sands. Basal gravel beds, although rare, have been noted. Up to 56 meters (185 ft) of the Citronelle Formation has been encountered in Area Characterization shallow borings in the Cypress Creek dome area. Good exposures of Citronelle are not common at the dome. However, low-angle, planar cross bedding and near-horizontal bedding were observed in some outcrops in the study area. Bedding is not commonly seen in boring samples from the Citronelle Formation.

Criteria were developed to distinguish sands and clays of the Hattiesburg Formation from those of the Citronelle Formation by utilizing analyses of heavy mineral assemblages of the two formations (see Mississippi Study Area Appendix). Analyses of heavy minerals indicated that both units commonly contain ilmenite, leucoxene, kyanite, tourmaline, staurolite, and tan opaques. The heavy mineral suite of the Hattiesburg Formation, however, also includes epidote, garnet, and hornblende, minerals which are not found in the Citronelle Formation. The establishment of these diagnostic criteria, as well as additional field work, resulted in the modification of Bowen's map (1979) into the present geologic map (Figure 13-12).

The Citronelle Formation unconformably overlies the Hattiesburg Formation. The Citronelle, which is a nearly flat-lying unit, was deposited on an erosional surface which has a total relief of about 61 meters (200 ft) across the near-dome area. In the areas in which Area Characterization shallow borings were drilled, the elevation of the contact varies from about 18 meters (60 ft) MSL in the southeastern portion of the dome area to 78 meters (257 ft) MSL in the northern portion (Figure 13-22).

Quaternary alluvium, which includes swampy deposits, is present in the modern stream valleys (Figure 13-12). The color of the alluvium varies from tan to grayish-tan, yellowish-orange and mottled gray, tan, brown, and dark brown. The sediments commonly include silt, clay, silty, fine-grain sand, and coarse to fine-grain quartz and cherty gravel. Up to 15 meters (50 ft) of alluvium has been encountered. Dark brown organic material is abundant, especially in the swamp deposits. Laminations and bedding are rarely observed in boring samples.

13.1.2.3 Structure: Cypress Creek Dome is on the northern flank of the Perry Basin, discussed previously in Section 12.2.3.2. The salt stock has pierced Jurassic, Cretaceous, and early Tertiary strata and it has penetrated Miocene beds. Structural contours of the tops of eight Late Cretaceous and Tertiary Formations (Figures 12-13 through 12-20) indicate the positions of the dome, the Perry Basin, and other structural features in the study area. These structural maps do not indicate that the salt stock has a pronounced influence on the near-dome geologic structure. This may be caused in part by the paucity of well data in the dome area and in part by a dominating influence of the subsidence in the adjacent Perry Basin.

The attitude of the strata adjacent to the dome shallower than -914 meters (-3,000 ft) MSL was interpreted from three high-resolution seismic reflection lines (Figures 13-9 through 13-11). Two of these lines (Figures 13-9 and 13-11) show relatively flat-lying Eocene through Miocene age beds on the northern and northwestern flanks of the dome. These beds are upturned approximately 61 to 152 meters (200 to 500 ft) within 610 meters (2,000 ft) of the dome flank. The third line (Figure 13-10) is approximately perpendicular to the local strike and shows all of the beds on the southern flank of the dome dipping gently away from the dome between approximately 38 and 57 m/km (200 and 300 ft/mi). The maximum relief on any of the Tertiary reflectors, as interpreted from the high-resolution seismic data, is approximately 259 meters (850 ft) and it occurs on the southern flank of the dome (Figure 13-10). This greater relief on the southern flank of the dome may result from its proximity to the center of the Perry Basin.

The strata below -914 meters (-3,000 ft) MSL, as interpreted on structure contour maps (Figures 12-13 through 12-20), dip southerly toward the axis of the Perry Basin. A geologic section through Cypress Creek Dome also illustrates the basinward dip of these near-dome strata (Figure 13-7). In the vicinity of Cypress Creek Dome there are no small, localized, closed structural depressions similar to those found near other domes. In this sense, rim synclines have not been identified. However, the Perry Basin is thought to be a salt withdrawal feature related to Cypress Creek Dome (discussed in Section 12.2.3.2) and it may be the largest rim syncline identified in the study area.

Several faults near the dome have been identified from well data and seismic reflection data. Fault Zone F-8 is on the southeastern flank of Cypress Creek Dome (Figure 12-12) and it consists of at least three faults. A detailed discussion of

Fault Zone F-8 is presented in Section 12.2.3.4.5.8. The position of these faults in the stratigraphic section suggests that one of the faults may pre-date initial diapiric movement of the dome. This may imply that the fault zone controlled the position of the salt dome, rather than that salt movement caused the faulting.

Additional faulting is interpreted approximately 1.6 km (1 mi) north-northwest of the dome on Seismic Line F-F' (Figure 12-30). This line shows four faults in the Hosston through Ferry Lake interval. Displacement along these faults ranges from about 30 to 91 meters (100 to 300 ft). Another fault on the same line is interpreted in the Wilcox Group within 1.6 km (1 mi) of the dome, displacing beds approximately 30 meters (100 ft) to the northeast. These faults may be oriented radially from Cypress Creek Dome and they are probably caused by adjustments of strata in response to tensional forces created by vertical domal movement.

An analysis of lineaments detected by remote sensing is discussed in Section 13.1.2.1. Most lineaments in the dome area (Figure 13-17) appear to be related to either drainage or topography. Faults interpreted to occur in the subsurface were projected to the surface at angles consistent with those of known faulting in the Gulf Coastal Province, but no correlation was recognized between the projected faults and observed lineaments.

Analyses of the structure of the surficial units (Figures 13-18 through 13-22) indicate that subsidence of supradomal beds has taken place in Quaternary time. This is shown by the presence of a closed depression on the Hattiesburg-Citronelle contact over the dome crest (Figure 13-22). The area above this depression is filled with an anomalously thick section of Quaternary alluvium. In addition, a reduction-oxidation sequence in the Quaternary alluvium also indicates subsidence over the dome.

A closed depresssion with at least 11 meters (35 ft) of relief exists from elevations about 29 to 40 meters (95 to 130 ft) MSL on the Hattiesburg-Citronelle contact over the dome. The depression is probably an expression of structurally controlled relief resulting from subsidence, and it appears to be superimposed upon the erosional relief of the unconformable Hattiesburg-Citronelle contact, discussed in Section 13.1.2.2.2 (Figure 13-22). The closed depression on the unconformity surface in the supradomal area is apparent evidence of Miocene subsidence. An alternative explanation for the depression is that a northwesterly trending Citronelle-age stream valley eroded the supradomal Hattiesburg surface, producing the depression (Figure 13-22). However, convincing evidence of an outlet for this channel was not found.

In addition to the closed depression of the erosional Hattiesburg surface, an anomalously thick section of Quaternary alluvium was found in the supradomal area (Figures 13-19 and 13-21). Approximately 15 meters (50 ft) of alluvium was encountered over the depression in the Hattiesburg-Citronelle contact beneath the swamp. An alternating oxidation-reduction sequence in successive layers of sediment and organic material in the alluvium suggests infilling of a subsiding area and temporary, cyclical impoundment of drainage. In contrast, alluvium in the flood plain of Cypress Creek to the south of the supradomal area is less than 3 meters (10 ft) thick (Figure 13-19). Alluvium elsewhere in the swamp is not as thick as that over the depression and does not exhibit an oxidation-reduction sequence. This shallow, subsurface evidence for domal subsidence is supported to some extent by evidence of possible dissolution of the salt, as discussed in Section 14.3.2.3.

13.1.3 MINERAL RESOURCES: Proven mineral resources in the Cypress Creek Dome area consist solely of hydrocarbons. Past production of sand and gravel is inferred from the presence of gravel pit symbols on topographic maps of the area. However, field examinations revealed no recent use of sand, gravel, or clay, nor did they disclose the occurrence of any deposits of these minerals which might be commercial. Useable clay is present in the Hattiesburg Formation, but its thickness, distribution, and quality have not been determined. This clay is present in more advantageous locations outside the near-dome area, closer to railroads, highways, utilities, and labor (Mellen, 1979).

13.1.3.1 Hydrocarbons: A three-well oil and gas field, Camp Shelby Field, is located on the flanks of Cypress Creek Dome. The earliest exploratory drilling in the near-dome area consisted of two wells drilled in 1937 and 1938 and then abandoned. Following these unsuccessful early attempts, there was no further drilling until 1971 when Shell Oil Company began drilling the first of seven wells in the near-dome area (Table 12-2).

One well was relocated because of drilling problems, two wells were abandoned, and another well was converted to a salt water disposal well. Of the remaining wells, one produces oil and gas from the Clayton Formation, and the other two produce oil and gas from the Paluxy Formation (Mississippi State Oil and Gas Board, 1980).

The gas produced is not sold but it is used in oil-pumping operations (Mellen, 1979). Total cumulative production from the three wells was 34,857 m^3 (219,228 bbl) of oil and 4,297,786 liters (151,758 ft^3) of gas from September 1972 to December 1979. Current production is steady at about 4,134 m^3 (26,000 bbl) of oil a year (Mellen, 1979).

Although Cypress Creek Dome is situated along the extension of a productive trend, evaluation of available information by Murray (1979) indicated that the near-dome area has a poor to fair potential for future hydrocarbon production. Any additional production will probably come from within 305 to 457 meters (1,000 to 1,500 ft) of the salt-sediment contact and is unlikely to extend over 0.8 km (0.5 mi) beyond the dome flank. Future production is not likely to exceed 159,000 m^3 (1 million bbl) of oil or gas equivalent combined, and probably less (Murray, 1979).

Extensive seismic exploration has been conducted in the near-dome area and vicinity. The extent of this seismic reflection coverage was noted during selection of the seismic data purchased for the Area Characterization study. A common-depth-point (CDP) seismic survey, trending east-west across the northern flank of the dome, was in progress during December 1979. No current seismic exploration or drilling activities in the dome area are known.

13.1.3.2 Mineral Resource Potential: Murray, in 1979, investigated the resource potential of many of the commodities which could be extracted from an area within 3 km (2 mi) of the edge of the salt stock. In this study only four commodities or activities were rated as having better than fair potential for development. They are:

(1) Brining, good to excellent
(2) Recreation and general use, good to excellent
(3) Underground storage, good to excellent
(4) Agricultural products and farming, fair to good.

Other commodities considered to have, at best, a fair potential for development are:

(1) Heavy minerals
(2) Sand and gravel (surficial deposits)
(3) Hydrogen sulfide
(4) Geothermal, or geopressured materials (production by-products used locally)
(5) Carbon dioxide
(6) Construction materials.

However, in the context of current economics and marketability, none of these commodities are considered to have a commercial potential.

13.2 LAMPTON DOME

Lampton Dome, a shallow piercement salt dome in east-central Marion County, is approximately centered in Sections 20 and 21 of T3N, R17W (Figure 13-23). For the purposes of this study, an arbitrary near-dome area, 13 km (8 mi) in an east-west direction and 14 km (9 mi) in a north-south direction, was chosen for geologic characterization and comparison with the study area. For more precise reference the term supradomal area was chosen to designate that portion of the near-dome area overlying and enclosed by a surface projection of the -914-meter (-3,000-ft)-MSL salt contour. The study techniques and data utilized to characterize the geology of the near-dome area are discussed in Chapter 2 (Volume I). Specific types of data used in analysis, and data collection locations are shown in Figures 12-10, 13-24, 13-25 and Table 12-2.

13.2.1 DOME GEOMETRY AND COMPOSITION: Gravity modeling of Lampton Dome indicates that it has the form of an irregular ellipse, elongated northwest-southeast (Figures 13-23 and 13-26). A salt overhang is present around the dome between -2,438 and -4,877 meters (-8,000 and -16,000 ft) MSL (Figure 13-28). The salt stock is very steep-sided (Figures 13-29 to 13-31) except on the southern and southwestern flanks. In this area it spreads outward from an area of approximately 3.9 km^2 (1.5 mi^2) at about -4,572 meters (-15,000 ft) MSL to an area of approximately 18 km^2 (7 mi^2) at -6,096 meters (-20,000 ft) MSL.

The following table summarizes area of the salt, as determined by planimetry, at three levels (Figure 13-25).

Elevation (feet MSL)	Depth Range (feet)*	Area (acres)**
-2000	2220 to 2370	1075
-2500	2720 to 2870	1148
-3000	3220 to 3370	1236

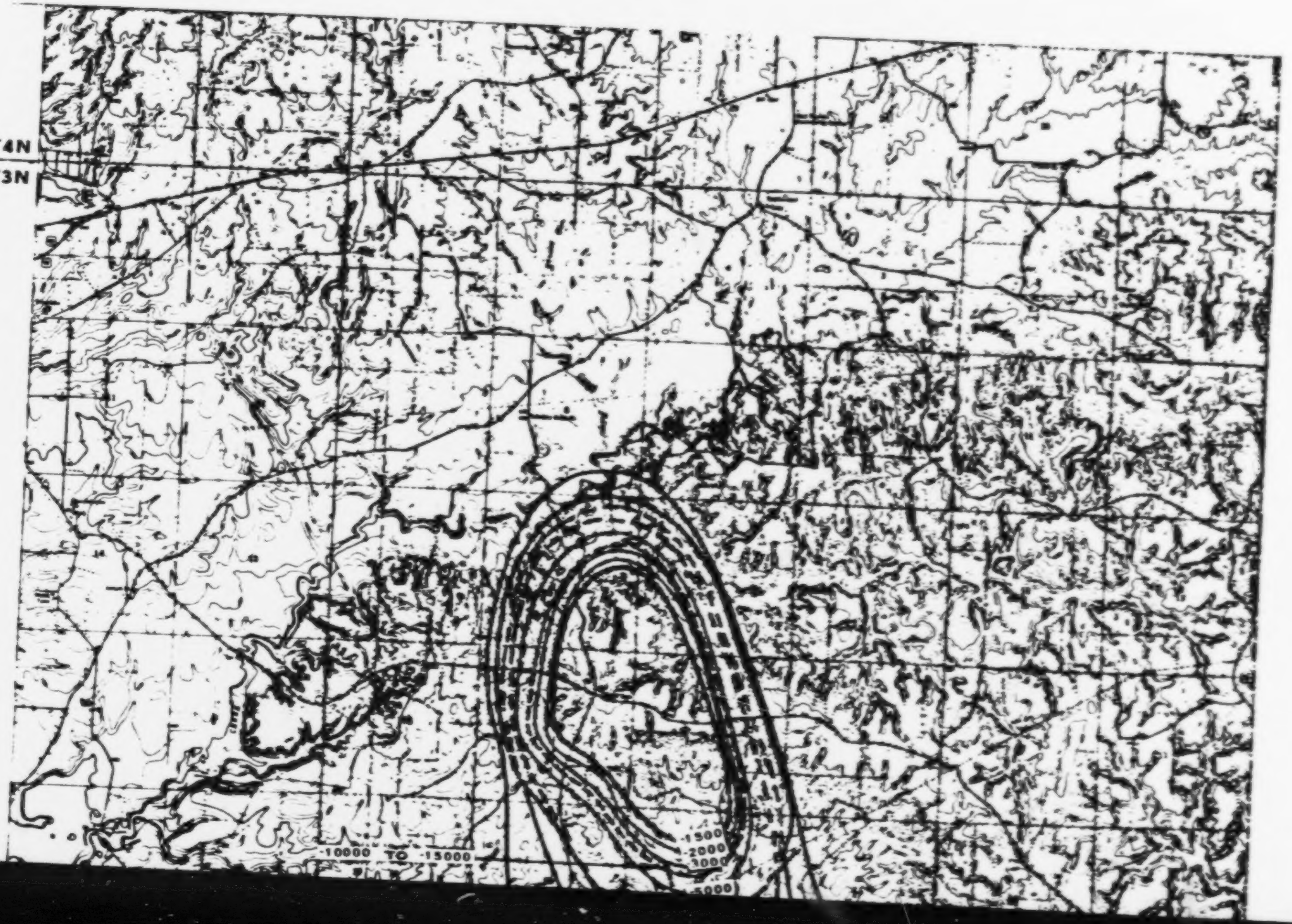
---

*To convert to meters, multiply by 0.3048.
**To convert to hectares, multiply by 0.4047.

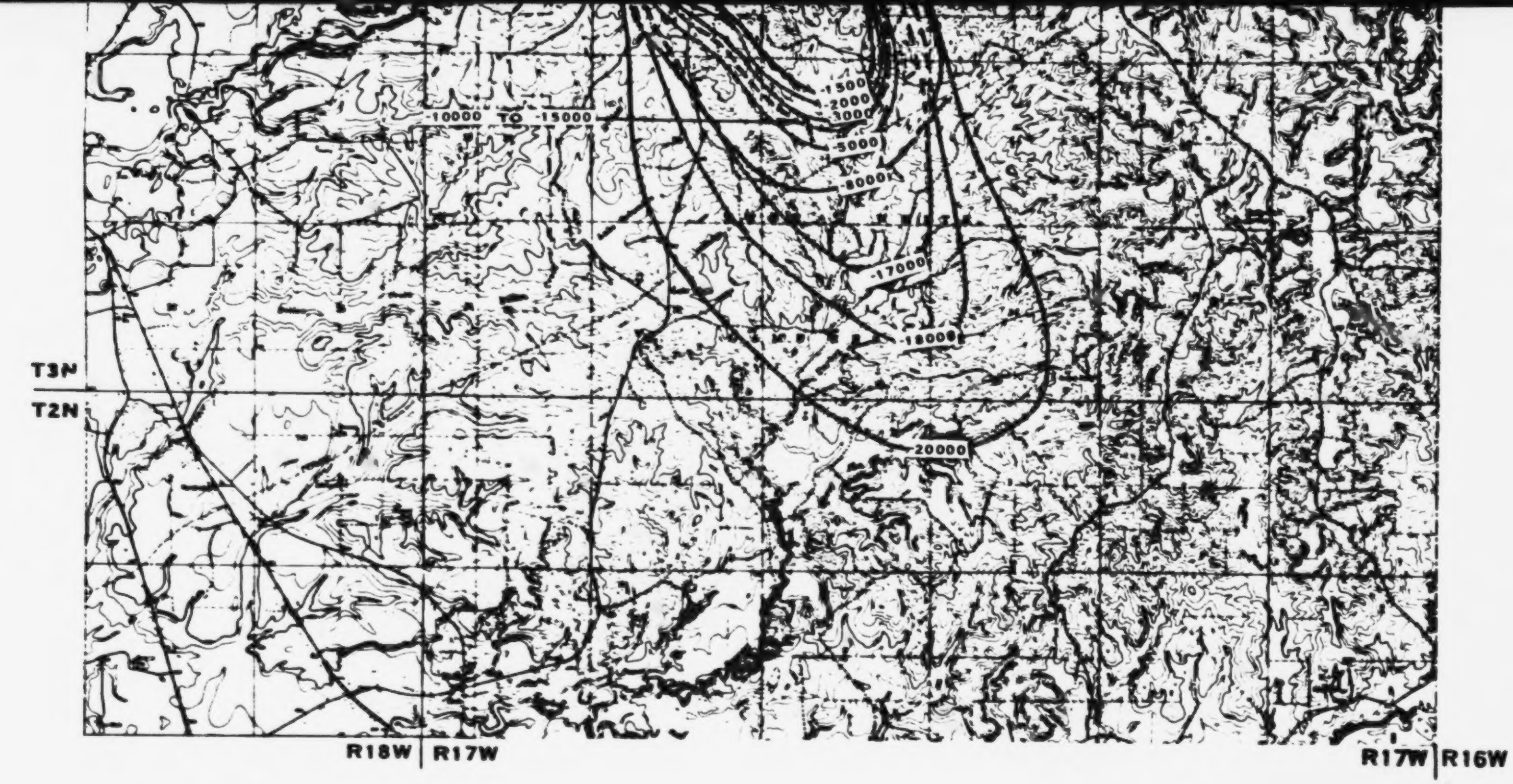
Calculations based on the gravity model of the dome indicate that, over the supradomal area, caprock is approximately 30 to 61 meters (100 to 200 ft) thick. The top of the caprock was encountered in the various wells at depths from 398 to 481 meters (1,305 to 1,579 ft) (Table 12-2), corresponding to elevations of -305 to -394 meters (-1,000 to -1,293 ft) MSL. A sulfur test well, Exploro No. 6 Bradshaw (Figure 13-27), which encountered 20 meters (67 ft) of caprock before penetrating salt, was the only well to reach salt in the supradomal area. Seven other wells penetrated 11 to 80 meters (37 to 262 ft) of caprock. Well data indicate that the caprock contains anhydrite. There are no additional data to describe the nature of the caprock more precisely.

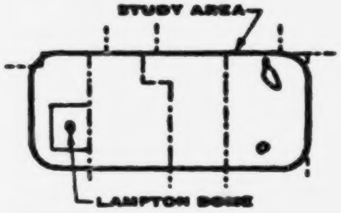
On the basis of a comparison of the dome gravity model and topographic information from USGS maps, the minimum depth to salt is approximately 463 meters (1,520 ft). In the Exploro Bradshaw No. 6 well, salt was encountered at a depth of 502 meters (1,646

176


T4N
T3N
N
-10000 TO -15000
-1500
-2000
-3000
-5000

BEST DOCUMENT AVAILABLE


-10000 TO -15000
-1500
-2000
3000
-5000
-8000
-17000
-18000
20000
T3N
T2N
R18W
R17W
R17W
R16W


STUDY AREA
LAMPTON DOME

LEGEND

——— -1500 — — — STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL 1000 FEET ON DOME SIDES. 500 FEET ON TOP OF DOME. DATUM IS MEAN SEA LEVEL.

176A

1 0 1 MILES

1 0 1 KILOMETERS

CONTOUR INTERVAL 10 FEET
BASE FROM U.S. GEOLOGICAL SURVEY
1:24,000 QUADRANGLE.

PREPARED	JDG	DATE	5-30-80
REVISED	DGP	DATE	1-13-81
REVISED		DATE	
APPROVED		DATE	[illegible]

T-1275-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

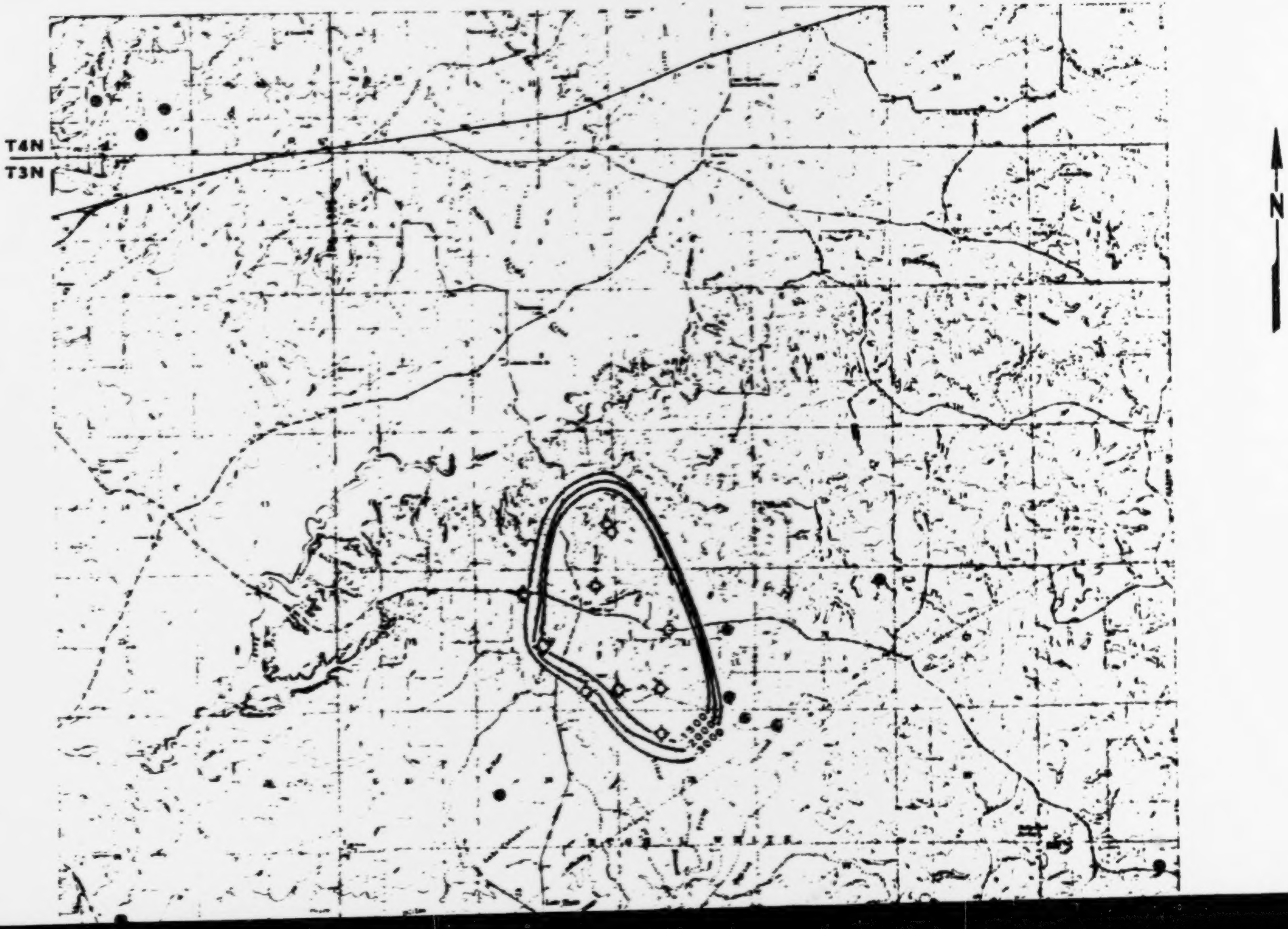
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

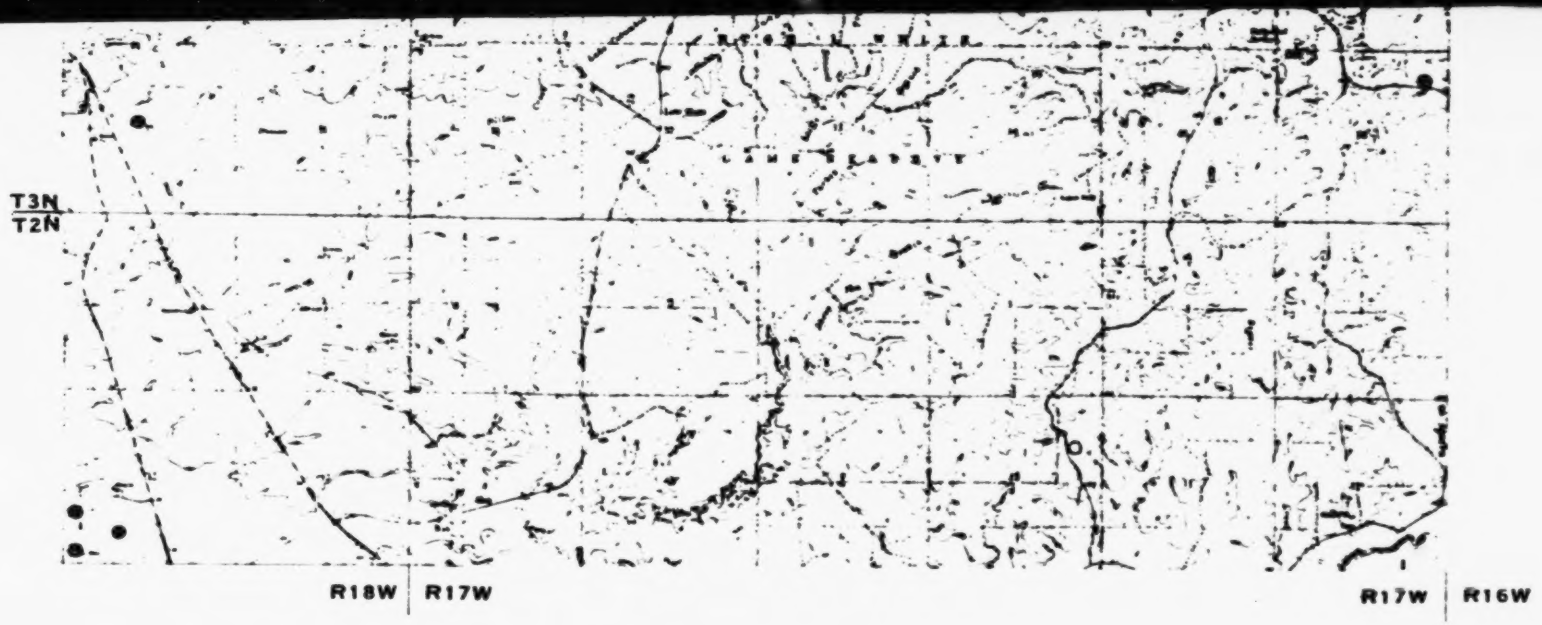
LAMPTON DOME
TOPOGRAPHIC MAP WITH STRUCTURE
CONTOURS ON SALT

JOB NO. MV9600

FIGURE 13-23

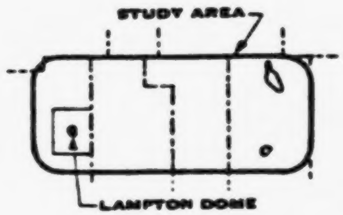

T4N
T3N
N
1500
2000
3000

177A



LEGEND

●	OIL OR GAS WELL
⌖	SULPHUR TEST WELL
○	AREA CHARACTERIZATION HYDROLOGIC BORING
—— -1800 ——	LINE OF EQUAL ELEVATION OF SALT IN FEET. DATUM IS MEAN SEA LEVEL.



1 0 1 MILES

1 0 1 KILOMETERS

CONTOUR INTERVAL 10 FEET.

BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLE.

PREPARED	J.D.G.	DATE	5-30-80
REVISED		DATE	
REVISED		DATE	
APPROVED		DATE	

T-1276-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

LAMPTON DOME

DATA UTILIZED IN ANALYSIS

JOB NO. MV9600

FIGURE 13-24

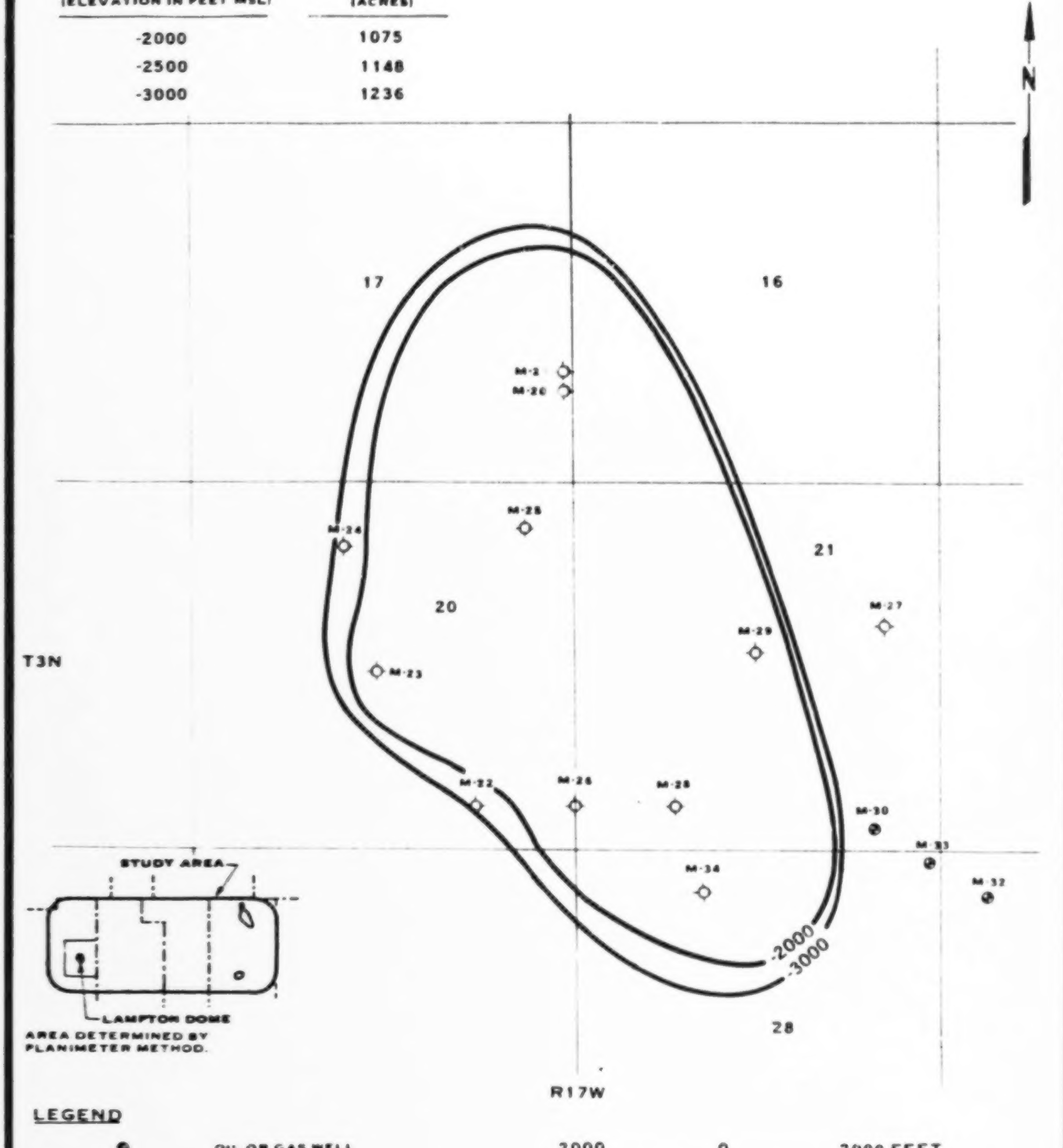
FIGURE 13-24

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

AF 12338A

SALT CONTOUR (ELEVATION IN FEET MSL)	AREA (ACRES)
-2000	1075
-2500	1148
-3000	1236



N
17
16
M-2
M-20
M-25
M-24
21
20
M-27
M-29
T3N
M-23
M-22
M-26
M-28
M-30
M-31
M-32
M-34
-2000
-3000
STUDY AREA
LAMPTON DOME
28
R17W
2000 0 2000 FEET
0.5 0 0.5 KILOMETERS

AREA DETERMINED BY PLANIMETER METHOD.

WELL KEY IN TABLE 12.3

LEGEND

● OIL OR GAS WELL

◇ SULPHUR TEST WELL

——-2000—— LINE OF EQUAL ELEVATION OF SALT INTERVAL 1000 FEET. DATUM IS MEAN SEA LEVEL.

PREPARED JCG DATE 5/4/[illegible]
REVISED [illegible] DATE [illegible]
REVISED ______ DATE ______
APPROVED [illegible] DATE [illegible]
T-1277-1

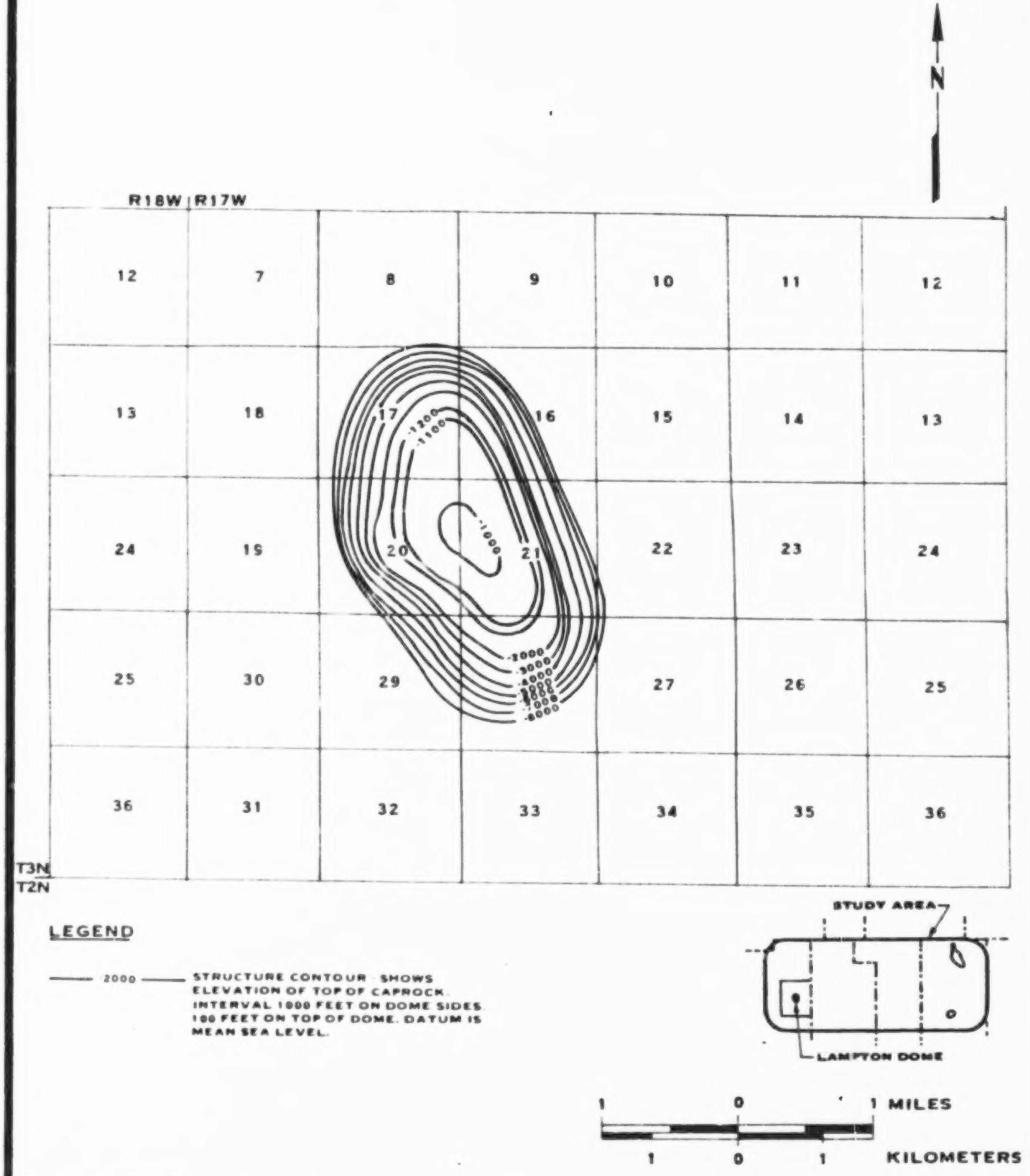
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
WELL LOCATION MAP

JOB NO. MV9600 FIGURE 13-25

BEST DOCUMENT AVAILABLE

AF 1233B


N
R18W
R17W
T3N
T2N
12
7
8
9
10
11
12
13
18
17
16
15
14
13
24
19
20
21
22
23
24
25
30
29
27
26
25
36
31
32
33
34
35
36
-1200
-1100
-1000
-2000
-3000
-4000
-8000
LEGEND
2000
STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF CAPROCK. INTERVAL 1000 FEET ON DOME SIDES. 100 FEET ON TOP OF DOME. DATUM IS MEAN SEA LEVEL.
STUDY AREA
LAMPTON DOME
1
0
1 MILES
1
0
1
KILOMETERS

PREPARED LAG	DATE 5-30-80
REVISED	DATE
REVISED	DATE
APPROVED	DATE

T-1278-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

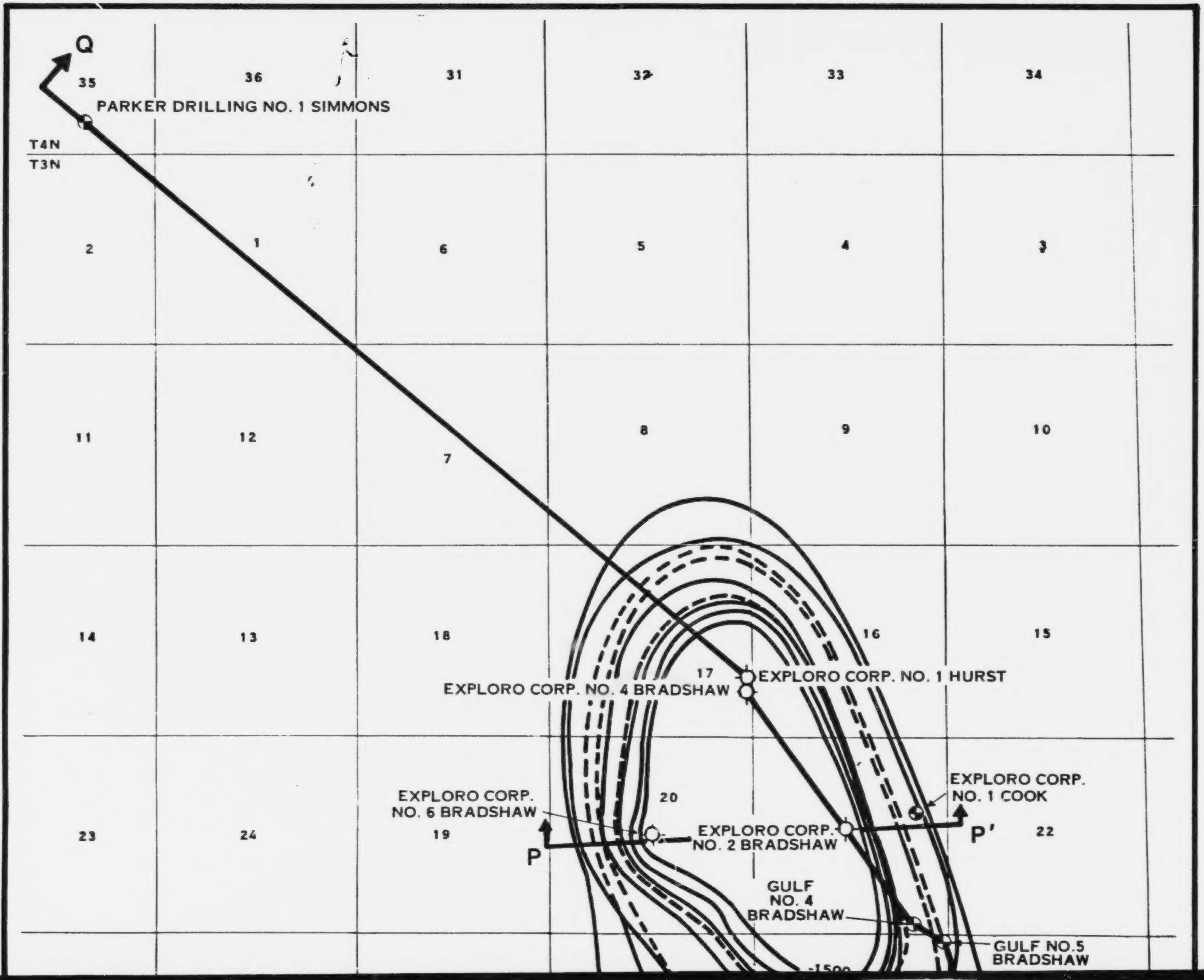
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
STRUCTURE CONTOUR MAP OF TOP OF CAPROCK

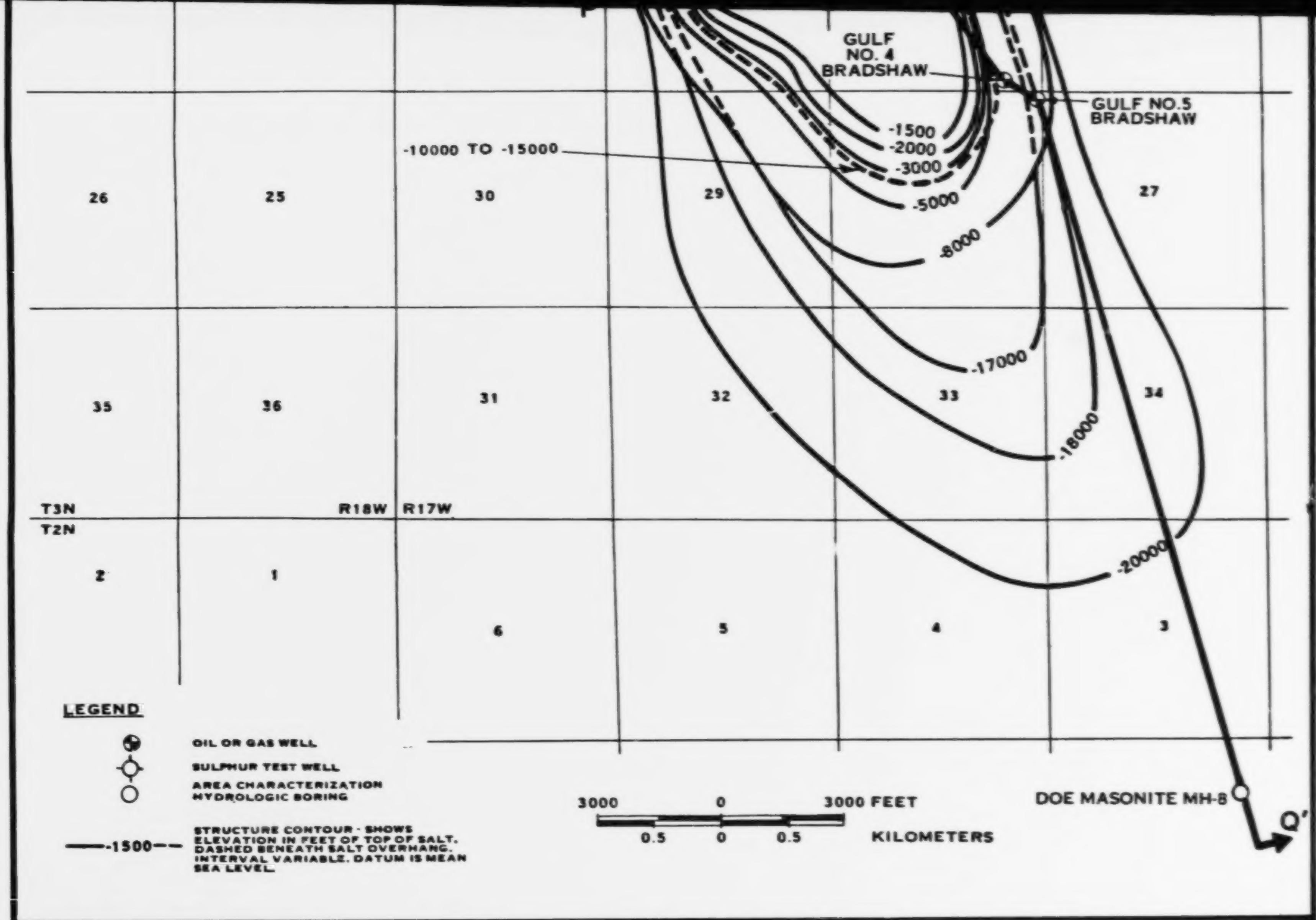
JOB NO. MV 9600

FIGURE 13-26

18D


Q
35
36
31
32
33
34
PARKER DRILLING NO. 1 SIMMONS
T4N
T3N
2
1
6
5
4
3
11
12
7
8
9
10
14
13
18
16
15
17
EXPLORO CORP. NO. 1 HURST
EXPLORO CORP. NO. 4 BRADSHAW
EXPLORO CORP. NO. 1 COOK
20
EXPLORO CORP. NO. 6 BRADSHAW
EXPLORO CORP. NO. 2 BRADSHAW
23
24
19
22
P
P'
GULF NO. 4 BRADSHAW
GULF NO.5 BRADSHAW
-1500

18DA


GULF
NO. 4
BRADSHAW
GULF NO.5
BRADSHAW
-10000 TO -15000
-1500
-2000
-3000
-5000
-8000
-17000
-18000
-20000
26
25
30
29
27
35
36
31
32
33
34
T3N
T2N
R18W
R17W
2
1
6
5
4
3
DOE MASONITE MH-8
Q'
3000
0
3000 FEET
0.5
0
0.5
KILOMETERS
LEGEND
OIL OR GAS WELL
SULPHUR TEST WELL
AREA CHARACTERIZATION HYDROLOGIC BORING
-1500-- STRUCTURE CONTOUR - SHOWS ELEVATION IN FEET OF TOP OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL VARIABLE. DATUM IS MEAN SEA LEVEL.

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1279-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
LOCATION MAP
GEOLOGIC SECTIONS P- P' AND Q - Q'

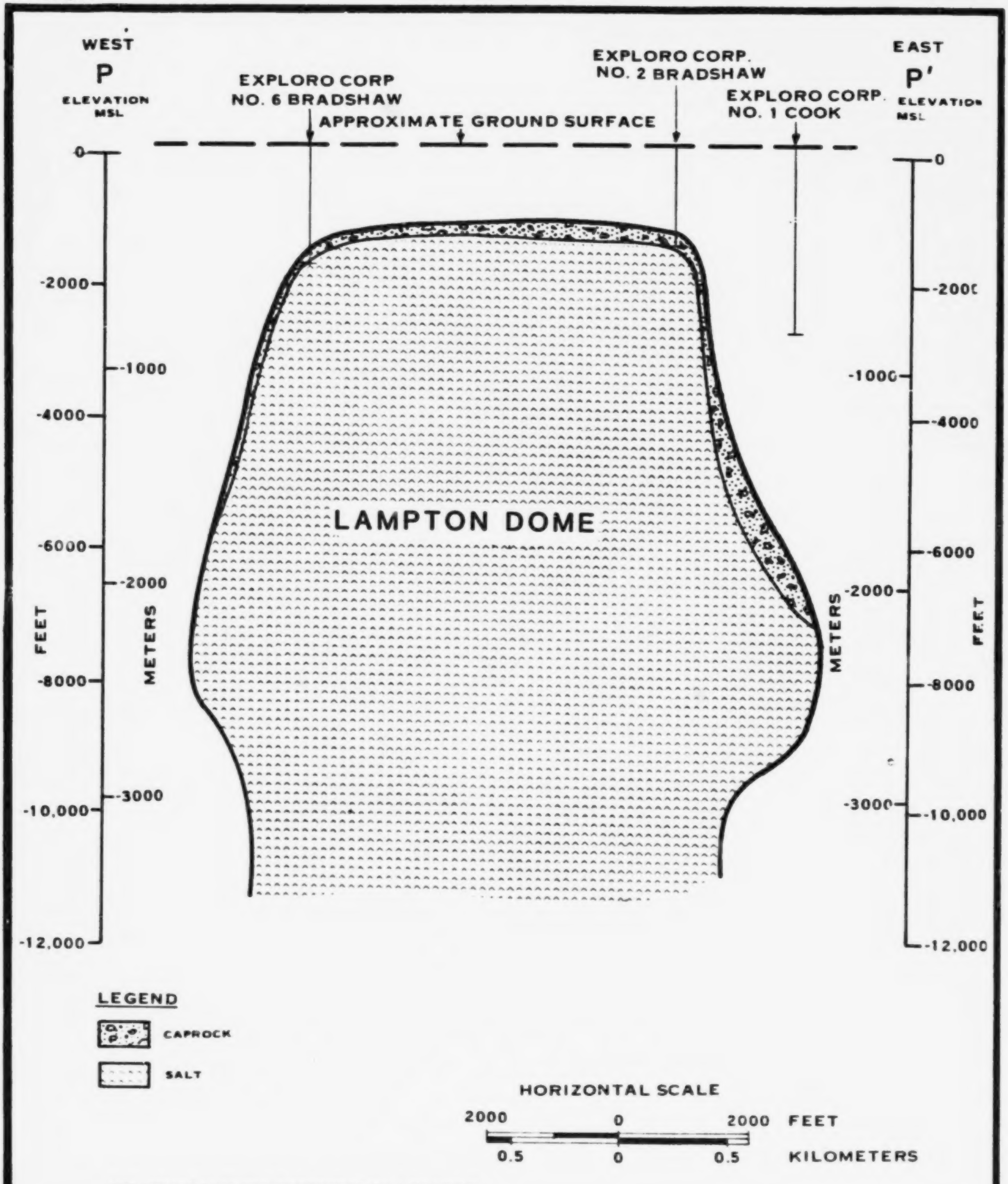
JOB NO. MV9600 FIGURE 13-27

FIGURE 13-27

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

AF 12338A


WEST
P
ELEVATION MSL
EXPLORO CORP NO. 6 BRADSHAW
APPROXIMATE GROUND SURFACE
EXPLORO CORP. NO. 2 BRADSHAW
EXPLORO CORP. NO. 1 COOK
EAST
P'
ELEVATION MSL
0
-2000
-1000
-4000
-6000
-2000
-8000
-3000
-10,000
-12,000
FEET
METERS
LAMPTON DOME
LEGEND
CAPROCK
SALT
HORIZONTAL SCALE
2000
0
2000
FEET
0.5
0
0.5
KILOMETERS

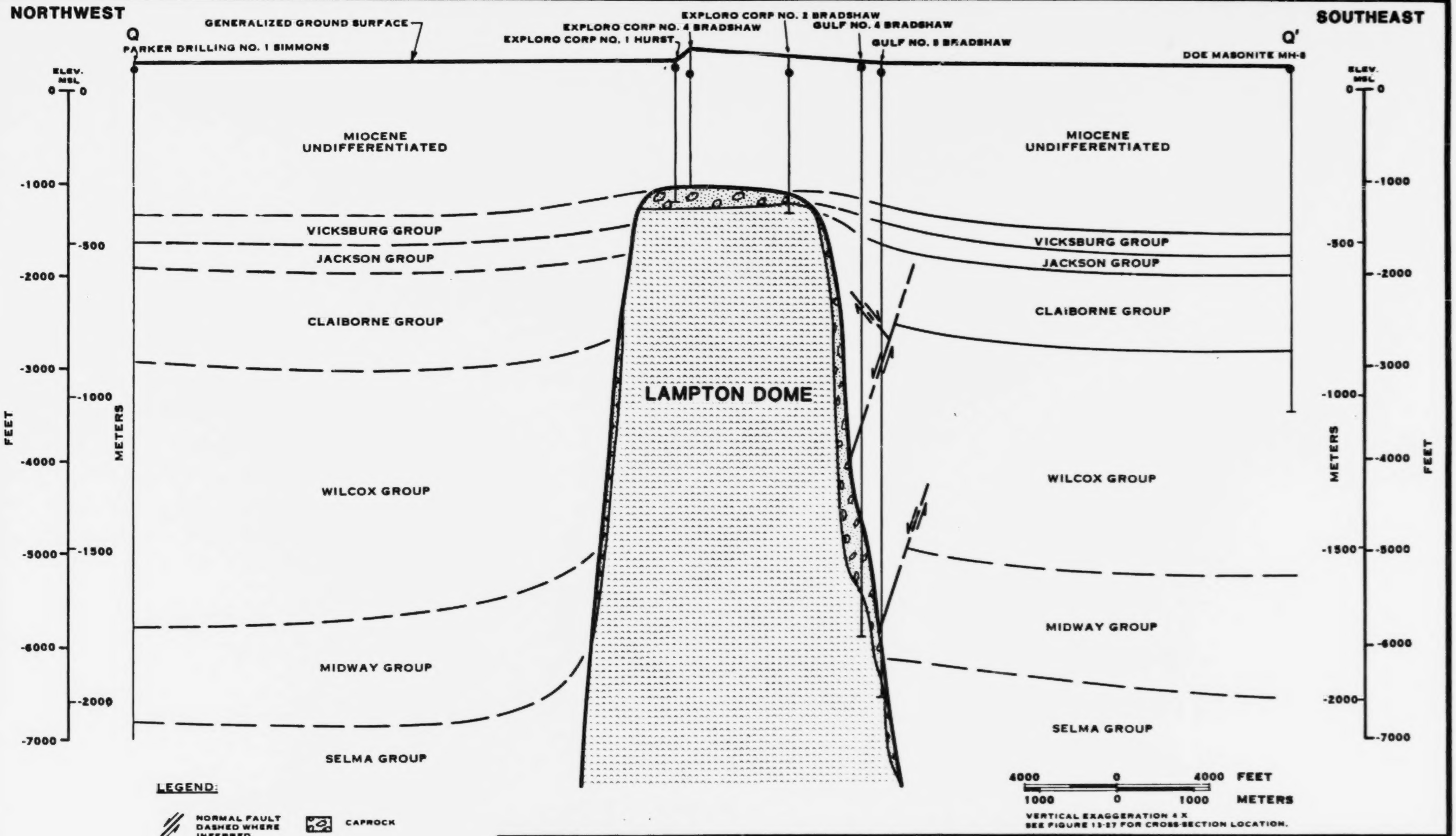
SEE FIGURE 13-27 FOR CROSS-SECTION LOCATION

PREPARED J.L.S. DATE 8-[illegible]-80
REVISED [illegible] DATE [illegible]
REVISED ____ DATE ___
APPROVED [illegible] DATE [illegible]
T-1434-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
TRUE SCALE DOME SECTION
P-P'
JOB NO. MV9600 FIGURE 13-2

BEST DOCUMENT AVAILABLE


NORTHWEST
SOUTHEAST
Q
Q'
GENERALIZED GROUND SURFACE
PARKER DRILLING NO. 1 SIMMONS
EXPLORO CORP NO. 1 HURST
EXPLORO CORP NO. 4 BRADSHAW
EXPLORO CORP NO. 2 BRADSHAW
GULF NO. 4 BRADSHAW
GULF NO. 5 BRADSHAW
DOE MASONITE MH-8
ELEV. MSL
0
-1000
-500
-2000
-3000
-1000
-4000
-5000
-1500
-6000
-2000
-7000
FEET
METERS
MIOCENE UNDIFFERENTIATED
VICKSBURG GROUP
JACKSON GROUP
CLAIBORNE GROUP
WILCOX GROUP
MIDWAY GROUP
SELMA GROUP
LAMPTON DOME
4000
0
4000
FEET
1000
0
1000
METERS
VERTICAL EXAGGERATION 4 X
SEE FIGURE 13-27 FOR CROSS-SECTION LOCATION.
LEGEND:
NORMAL FAULT DASHED WHERE INFERRED.
TOP & BOTTOM OF LOGGED INTERVAL.
CAPROCK
SALT

PREPARED JDG DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED Dap DATE 12/4/81

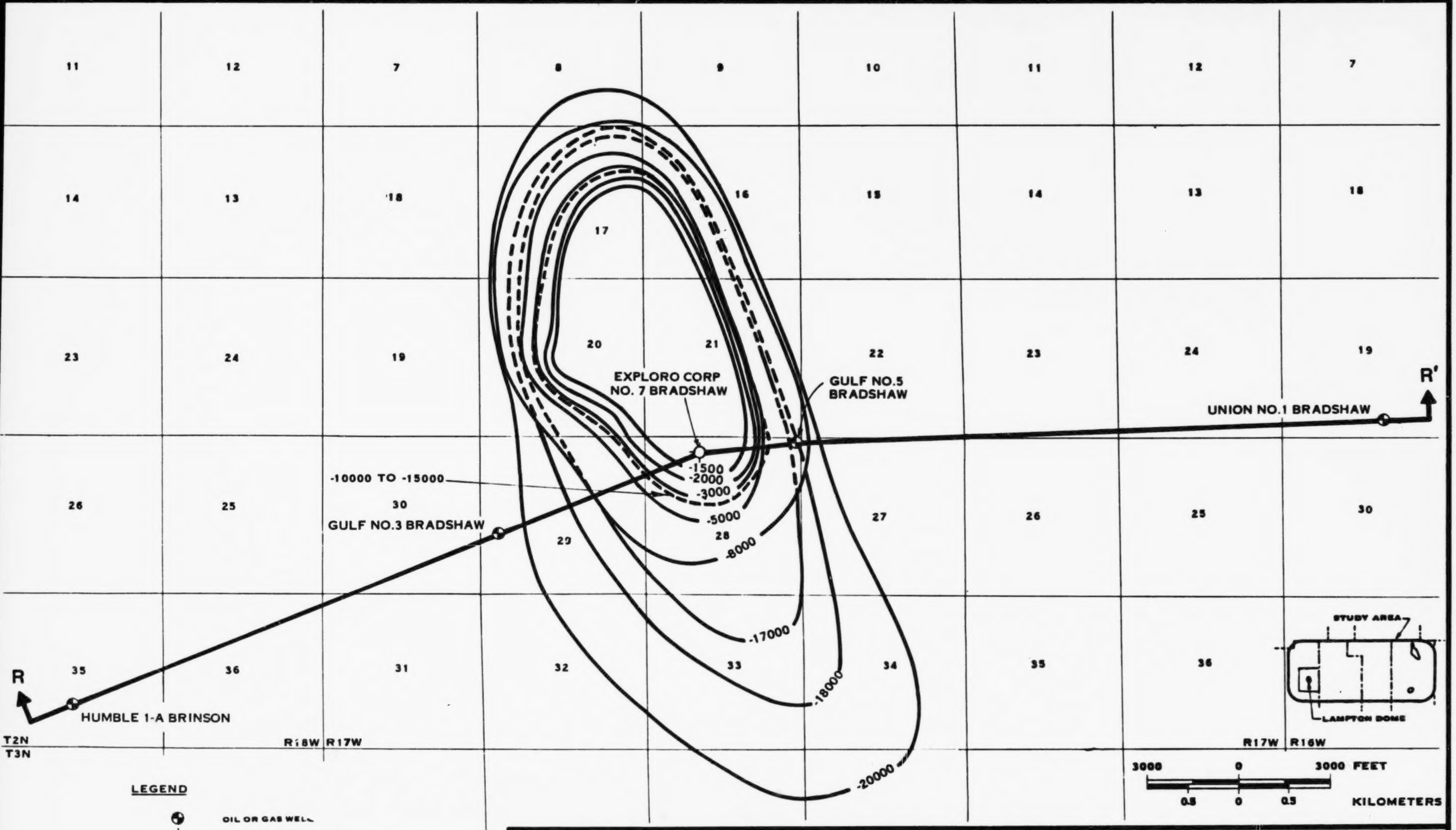
T-1280-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
GEOLOGIC SECTION Q - Q'

JOB NO. MV9600

FIGURE 13-29


11
12
7
8
9
10
11
12
7
14
13
18
17
16
15
14
13
18
23
24
19
20
21
22
23
24
19
26
25
30
28
27
26
25
30
35
36
31
32
33
34
35
36
29
R
R'
EXPLORO CORP NO. 7 BRADSHAW
GULF NO.5 BRADSHAW
UNION NO.1 BRADSHAW
GULF NO.3 BRADSHAW
HUMBLE 1-A BRINSON
-10000 TO -15000
-1500
-2000
-3000
-5000
-8000
-17000
-18000
-20000
T2N
T3N
R18W R17W
R17W R16W
STUDY AREA
LAMPTON DOME
3000 0 3000 FEET
0.5 0 0.5 KILOMETERS

LEGEND

- OIL OR GAS WELL
- SULPHUR TEST WELL
- —-1500— STRUCTURE CONTOUR - SHOWS ELEVATION IN FEET OF TOP OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL VARIABLE. DATUM IS MEAN SEA LEVEL.

PREPARED V.D.G. DATE 5-30-80
REVISED [illegible] DATE 12/3/81
REVISED DATE
APPROVED [illegible] DATE 8/10/81

T-1281-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

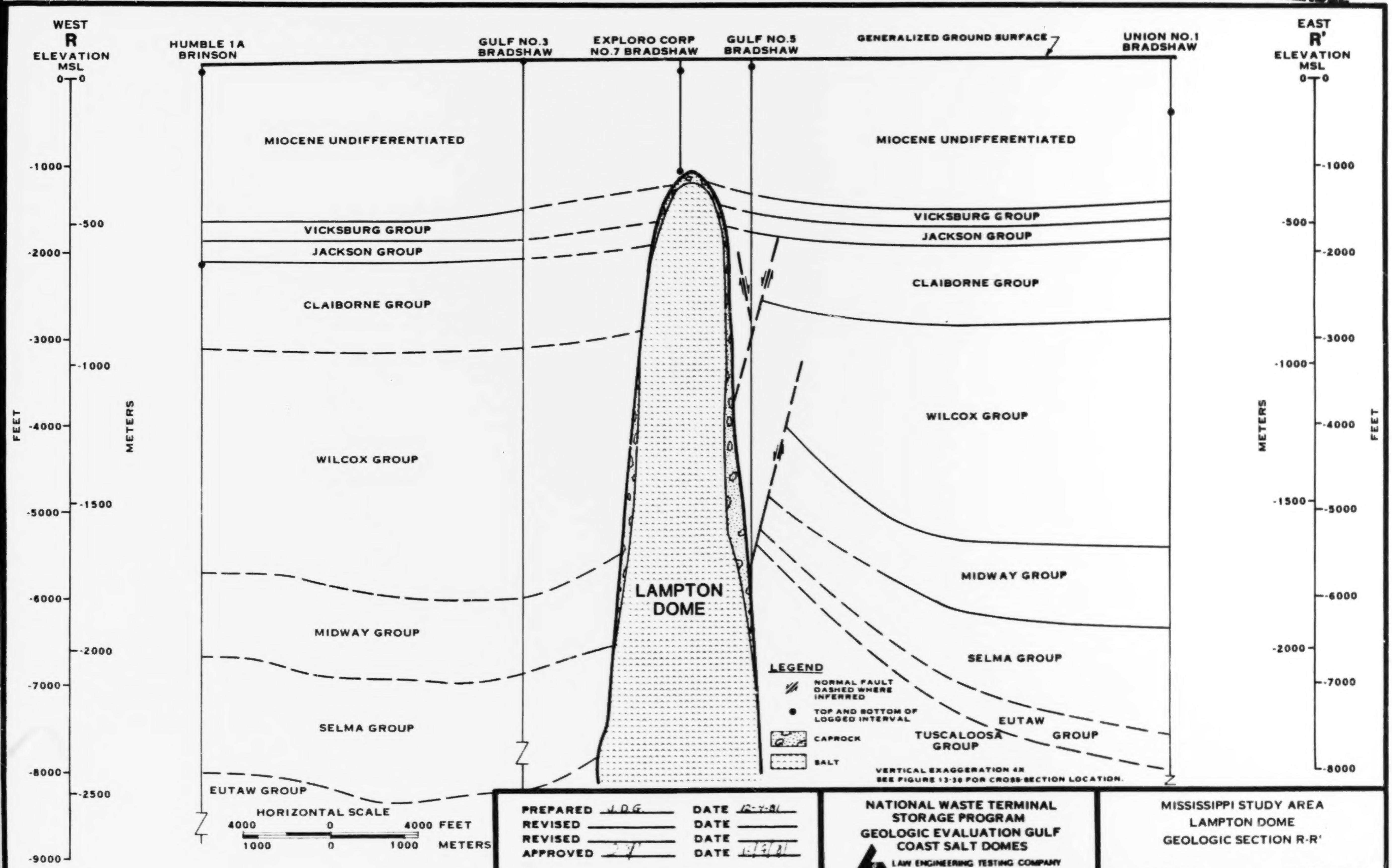
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
LOCATION MAP
GEOLOGIC SECTION R - R'

JOB NO. MV 9600

FIGURE 13-30

BEST DOCUMENT AVAILABLE


WEST
R
ELEVATION MSL
EAST
R'
ELEVATION MSL
HUMBLE 1A BRINSON
GULF NO.3 BRADSHAW
EXPLORO CORP NO.7 BRADSHAW
GULF NO.5 BRADSHAW
GENERALIZED GROUND SURFACE
UNION NO.1 BRADSHAW
FEET
METERS
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
-500
-1000
-1500
-2000
-2500
MIOCENE UNDIFFERENTIATED
VICKSBURG GROUP
JACKSON GROUP
CLAIBORNE GROUP
WILCOX GROUP
MIDWAY GROUP
SELMA GROUP
EUTAW GROUP
LAMPTON DOME
TUSCALOOSA GROUP
EUTAW GROUP
LEGEND
NORMAL FAULT DASHED WHERE INFERRED
TOP AND BOTTOM OF LOGGED INTERVAL
CAPROCK
SALT
VERTICAL EXAGGERATION 4X
SEE FIGURE 13-30 FOR CROSS-SECTION LOCATION.
HORIZONTAL SCALE
4000 0 4000 FEET
1000 0 1000 METERS

PREPARED J.D.G. DATE 12-7-81
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE [illegible]

T-1282-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
GEOLOGIC SECTION R-R'

JOB NO. MV9600

FIGURE 13-31

ft), which corresponds to an elevation of 415 meters (1,360 ft) below sea level.

13.2.2 NEAR-DOME GEOLOGY: This section describes surface features as well as the stratigraphy and structure of the strata in the near-dome area. A detailed discussion of stratigraphic units and relationships is contained in Section 12.2.2.

13.2.2.1 *Surface Features*: The Lampton Dome area is in the Piney Woods Physiographic Subprovince. The area is generally typical of the study area as a whole. The land surface is rolling to hilly as a result of mature drainage dissection developed in a denditric pattern on the Pascagoula-Hattiesburg and Citronelle Formations. Exceptions to this are the broad, flat flood plains of the Pearl River and Upper Little Creek which cross the area. Three man-made lakes, Columbia, Watts, and Bill Waller, are present in the Hugh L. White Game Reserve which occupies the south-central portion of the near-dome area. Land use is limited to industrial pine forests and farming.

The population of Marion County in 1970, according to the U.S. Bureau of the Census, was 22,871, corresponding to a distribution of about 42 people per square mile. The unincorporated township of Hub is in the southwestern portion of the near-dome area about 7 km (4.5 mi) from the supradomal area. The city of Columbia, with a 1978 population of 8,176 (Columbia, Mississippi Chamber of Commerce, 1980), and the unincorporated township of Lampton are situated about 10 km (6 mi) northwest and 7 km (4.5 mi) west, respectively, from the supradomal area.

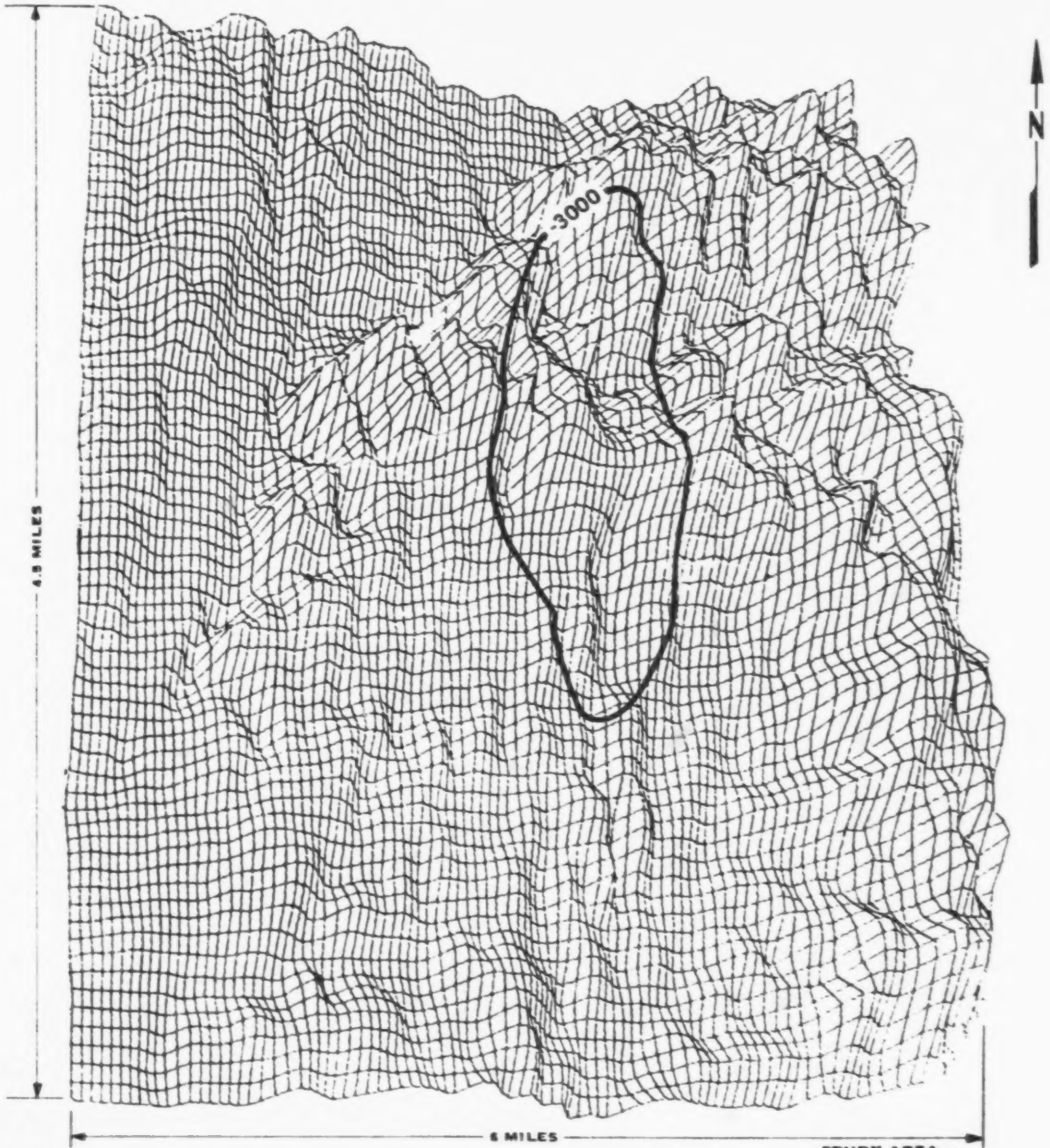
Approximately 85 percent of the near-dome area is privately owned, and the remainder is in the state-owned Hugh L. White Game Reserve. Industrial forests occupy about 60 percent of the land. The remaining 40 percent is used either for cultivation or pasture. The southern one-third of the supradomal area is occupied by the Hugh L. White Game Reserve, which includes the northeastern portion of Lake Bill Waller, and the rest is privately held.

Surface elevations in the near-dome area range from a low of about 37 meters (120 ft) MSL in the southwestern corner of the near-dome area on the Pearl River flood plain to a high of about 125 meters (410 ft) MSL on the crest of a flat-topped ridge in the east-central portion (Figures 13-23 and 13-32). This easterly trending ridge serves as a drainage divide between the northwesterly flowing tributaries of Upper Little Creek and numerous other creeks and their tributaries which flow southerly and southwesterly to join the Pearl River below its confluence with Upper Little Creek (Figure 13-33). Surface elevations above the supradomal area, which vary from about 58 to 113 meters (190 to 370 ft) MSL, are typical of the interstream topography elsewhere in the study area, suggesting that domal movement has not controlled the drainage courses or topographic development.

The principal drainage course, Upper Little Creek, drains the northwestern and northeastern portions of the near-dome area and flows southwesterly to join the Pearl River (Figure 13-33). South and east of Upper Little Creek, drainage is southerly and southwesterly in tributaries of Lower Little Prong Creek, which is south of the near-dome area. This southwesterly flow is

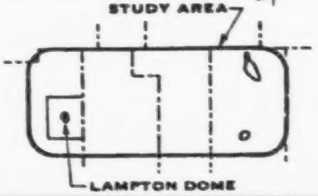
BEST DOCUMENT AVAILABLE

AF 12338A



LEGEND

-3000 LINE OF EQUAL ELEVATION OF SALT, IN FEET. DATUM IS MEAN SEA LEVEL.

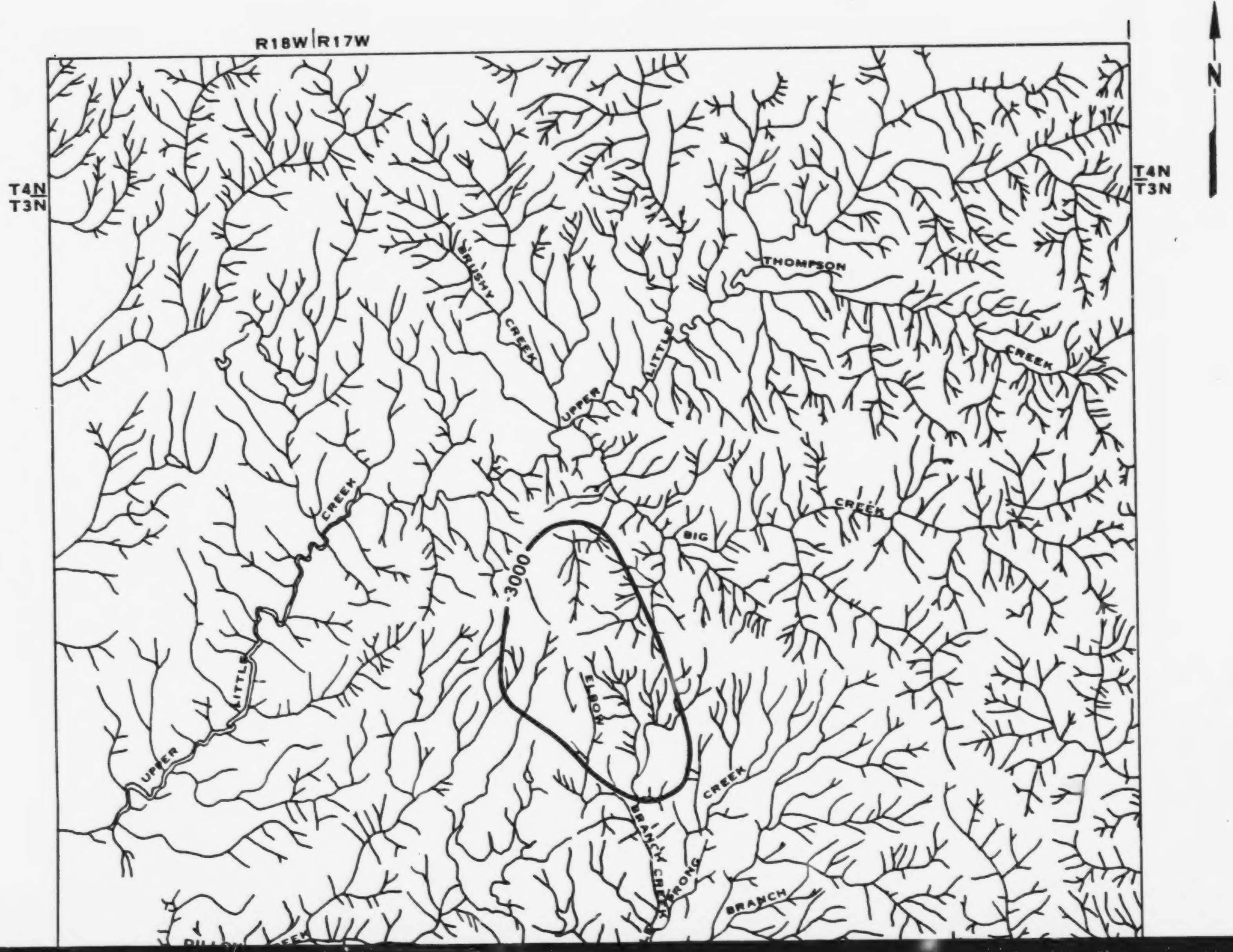


PREPARED LDG. DATE 5-30-80
REVISED DEP DATE [illegible]
REVISED ____ DATE ____
APPROVED [illegible] DATE 8/15/80
T-1283-1

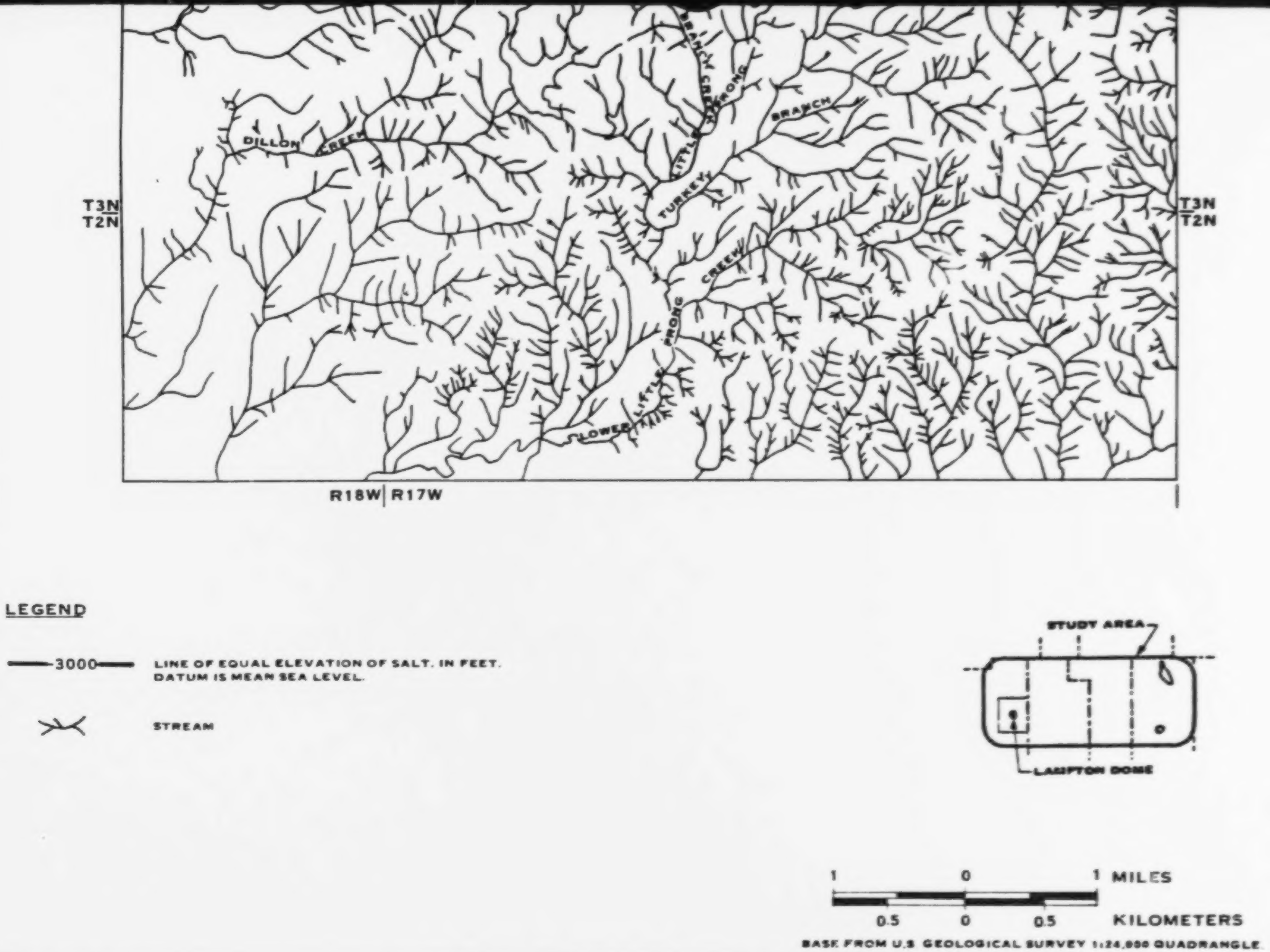
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
THREE-DIMENSIONAL TOPOGRAPHIC PROJECTION

JOB NO. MV9600 FIGURE 13-32


R18W | R17W
T4N
T3N
T4N
T3N
N
BRUSHY
CREEK
UPPER
LITTLE
THOMPSON
CREEK
CREEK
BIG
CREEK
3000
ELBOW
CREEK
BRANCH
CREEK
STRONG
BRANCH
UPPER
LITTLE
CREEK
DILLON
CREEK

188A


DILLON CREEK
BRANCH CREEK
PRONG
LITTLE
BRANCH
TURKEY
CREEK
PRONG
LITTLE
LOWER
T3N
T2N
T3N
T2N
R18W
R17W
LEGEND
3000
LINE OF EQUAL ELEVATION OF SALT, IN FEET. DATUM IS MEAN SEA LEVEL.
STREAM
STUDY AREA
LAMPTON DOME
1
0
1
MILES
0.5
0
0.5
KILOMETERS

BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLE.

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1284-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
DRAINAGE NETWORK

JOB NO. MV 9600

FIGURE 13-33

FIGURE 13-33

BEST DOCUMENT AVAILABLE

BLANK PAGE 189

typical of all drainage on the eastern side of the Pearl River drainage basin (Figure 12-7).

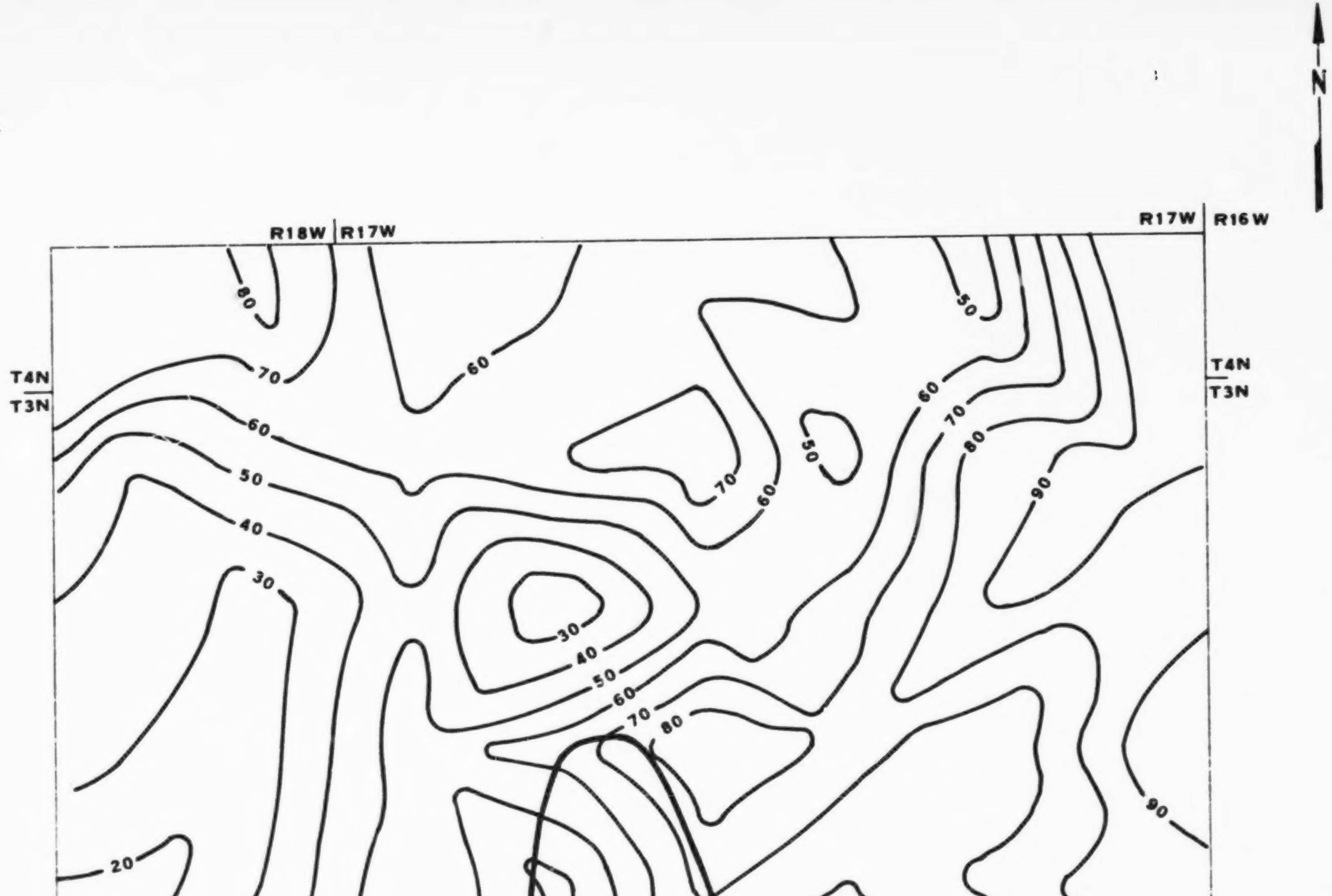
Drainage over the supradomal area forms a nearly radial pattern as a result of the influence of the drainage divide discussed above. Similar drainage patterns are present in several areas adjacent to the dome. Valley profiles indicate that streams seem to be downcutting actively and extending themselves headward. Analysis of drainage density in the near-dome area using contour maps of drainage link (segment of drainage trunk between tributary branches) frequency and ratios indicates that drainage patterns are apparently lithologically controlled. No clear evidence of structural influence resulting from domal movement is present (Figures 13-34 and 13-35).

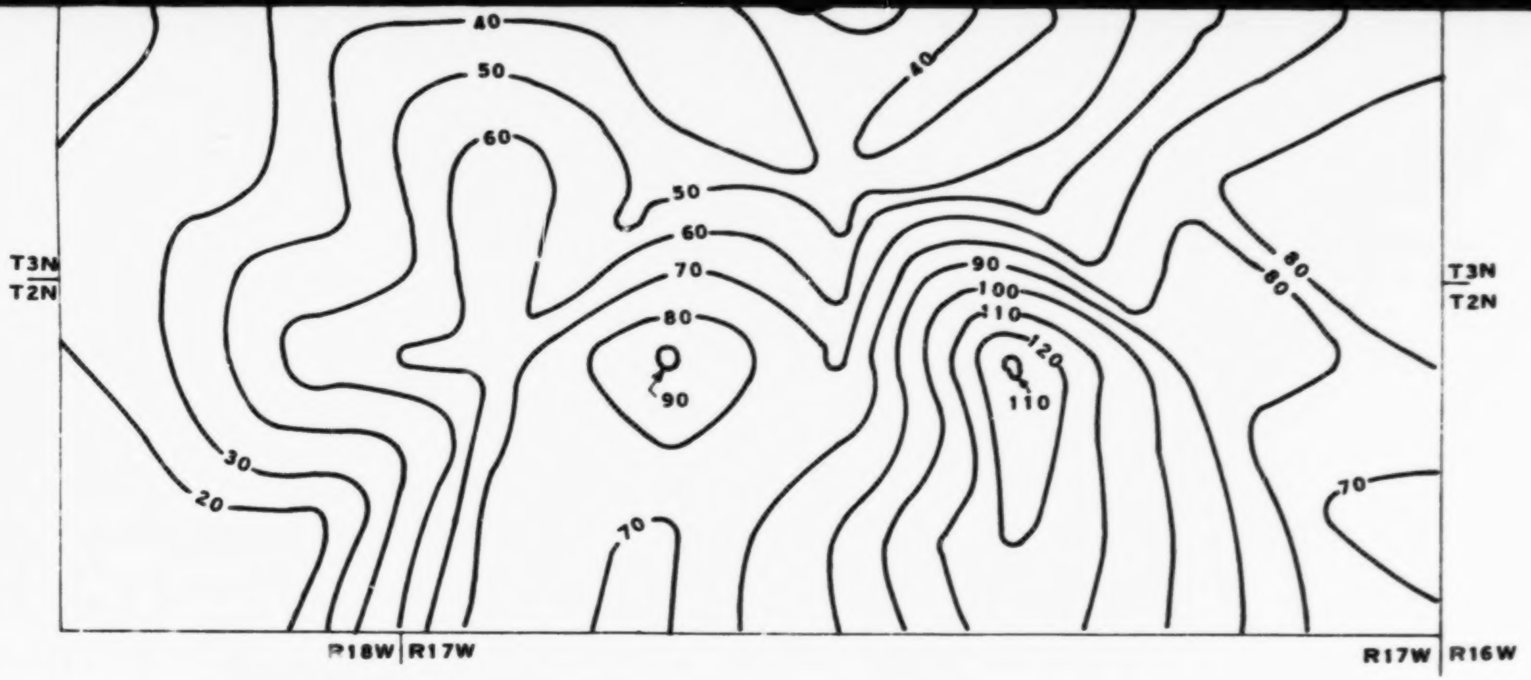
Precise information about the lithology and distribution of the stratigraphic units exposed is not available because of the unavailability of access to many areas during the Area Characterization field program. For this reason, surface mapping and shallow boring studies were not conducted. However, the Geologic Map of Mississippi (1969) indicates that Pascagoula-Hattiesburg beds are exposed over the major portion of the near-dome area (Figure 12-6). The Hattiesburg Formation was encountered at the surface in Area Characterization Well DOE MH-8 Masonite, drilled in the southeast portion of the area in 1979 (Figure 13-27). It consists of white to pink, very fine to very coarse-grain, quartz sands, interbedded with tan to yellowish and greenish-gray, silty and sandy clays.

The Geologic Map of Mississippi (1969) also indicates that the silty and clayey sands and gravels of the Citronelle are found in the east-central portion of the near-dome area. They probably support the ridge crest which forms the drainage divide between Upper Little and Lower Little Creeks. The topographic map of the near-dome area (Figure 13-23) shows that the valleys of the Pearl River, Upper Little Creek, and some of their tributaries have terraces developed in them; however, the age, attitude, origin, and correlation of the terraces are unknown because of the lack of field and published data. Recent alluvium is undoubtedly present in the flood plains of the larger streams.

Lineaments in the near-dome area were observed only on color infrared imagery. The lineaments generally trend northwesterly and southwesterly, corresponding to the orientation of the regional drainage (Figure 13-36). The density of lineations is typical of the entire Pearl River drainage basin, although lineament density is less than that to the east in the Pascagoula River Basin (Figure 12-8). The distribution and density of lineaments in the near-dome area do not appear to be structurally controlled.

Topographic maps indicate that 14 gravel pits have existed in the near-dome area. Current exploration or development of surface mineral resources other than sand and gravel is unknown. Section 13.2.3 describes the mineral resources of the Lampton Dome area in greater detail.


N
R18W
R17W
R17W
R16W
T4N
T3N
T4N
T3N
80
70
60
60
50
40
30
30
40
50
60
70
80
70
60
50
50
60
70
80
90
90
80
70
60
50
40
20
50
40
40
50
60
-3000

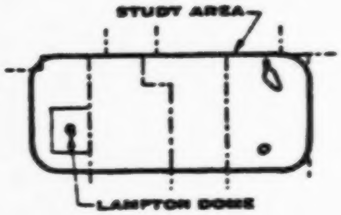

40
50
60
50
60
70
80
90
40
90
100
110
120
110
80
80
30
20
70
70
T3N
T2N
T3N
T2N
R18W
R17W
R17W
R16W

192A

LEGEND

-3000 LINE OF EQUAL ELEVATION OF SALT, IN FEET. DATUM IS MEAN SEA LEVEL.

30 LINE OF EQUAL NUMBER OF EXTERIOR/INTERIOR DRAINAGE LINKS PER SQUARE MILE.
INTERVAL 10 UNITS.


STUDY AREA
LAMPTON DOME

1
0
1
MILES
1
0
1
KILOMETERS

BEST DOCUMENT AVAILABLE

FIGURE 13-34

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

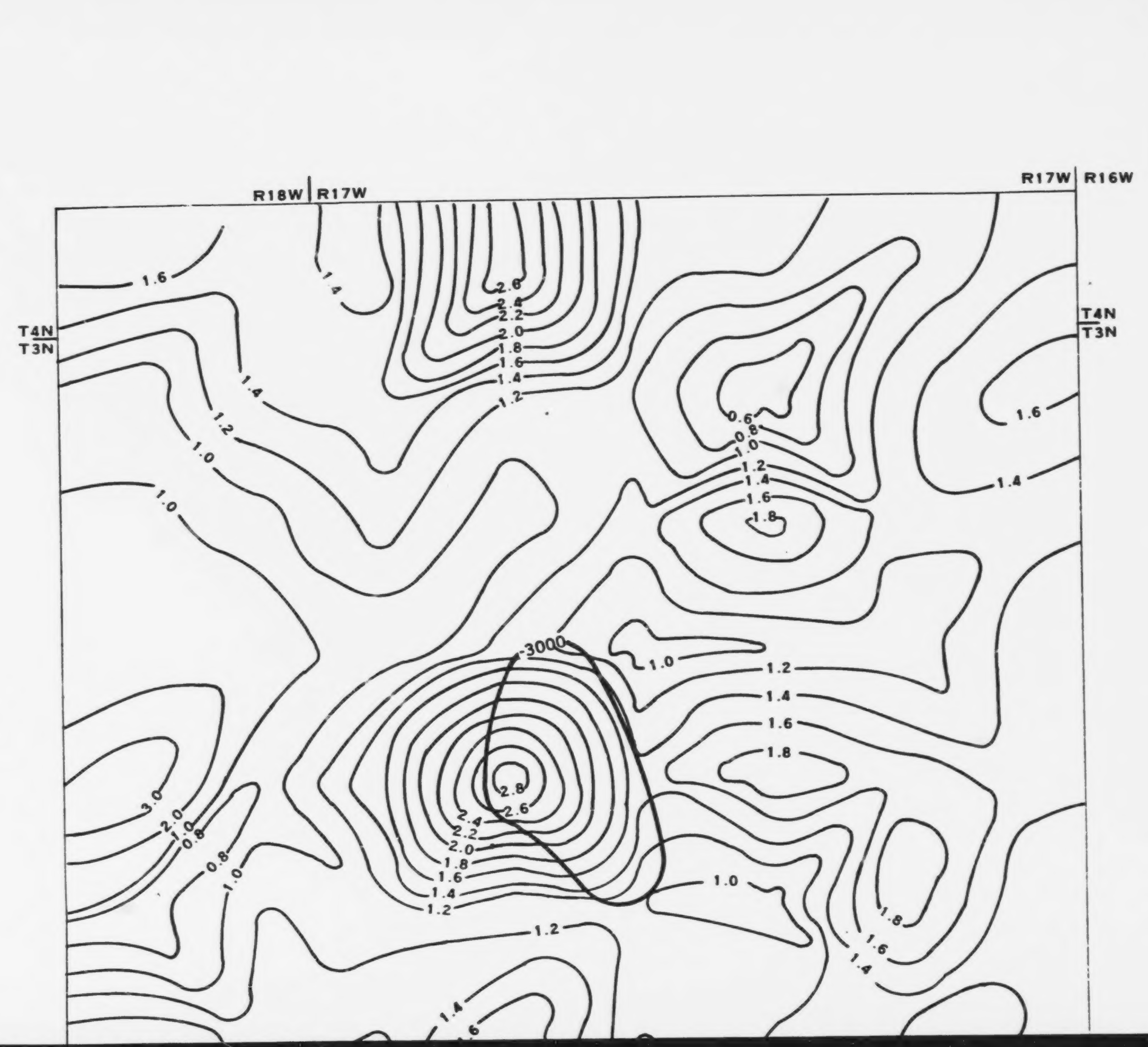
T-1285-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

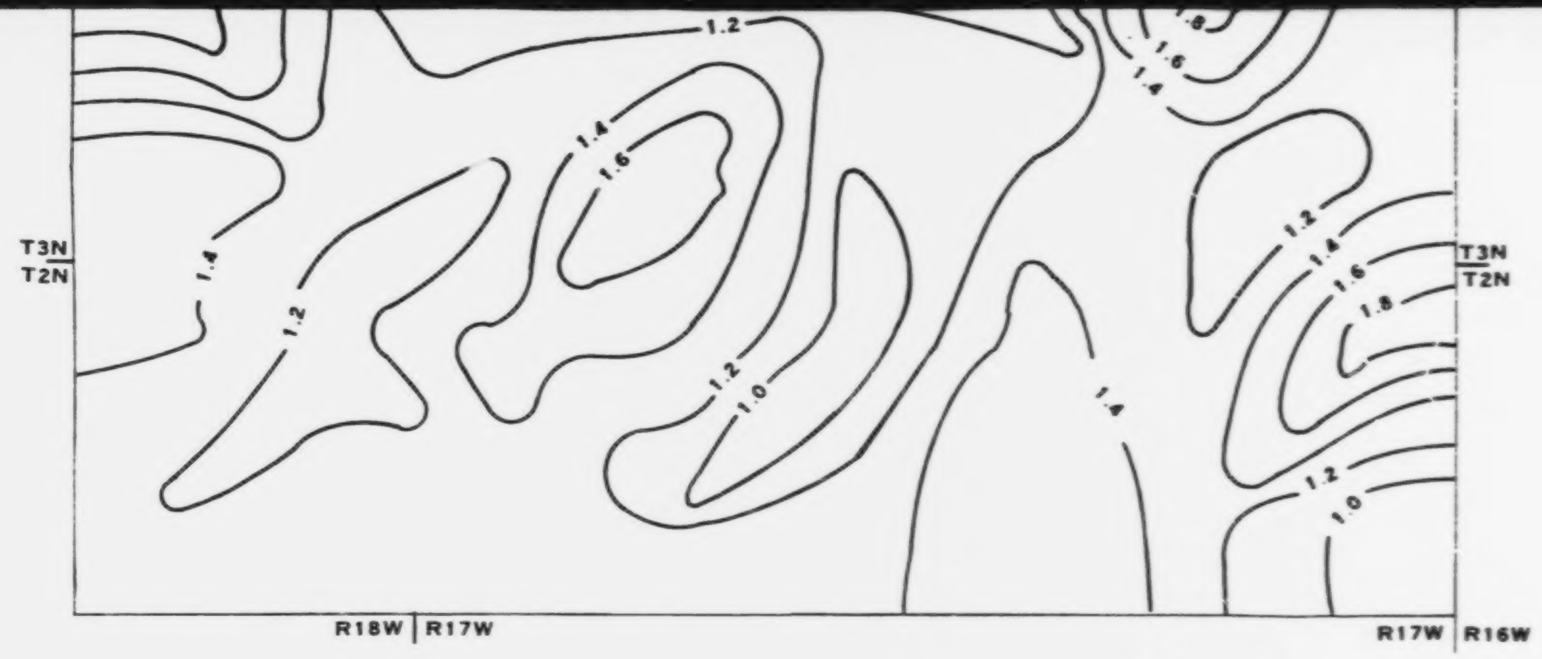
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
ISOLINES OF EXTERIOR/INTERIOR DRAINAGE LINK FREQUENCY

JOB NO. MV 9600 FIGURE 13-34


N
R18W
R17W
R17W
R16W
T4N
T3N
T4N
T3N
1.6
1.4
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.4
1.2
1.0
1.0
0.6
0.8
1.0
1.2
1.4
1.6
1.8
1.6
1.4
-3000
1.0
1.2
1.4
1.6
1.8
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
3.0
2.0
1.0
0.8
0.8
1.0
1.0
1.2
1.8
1.6
1.4
1.4
1.6

193A

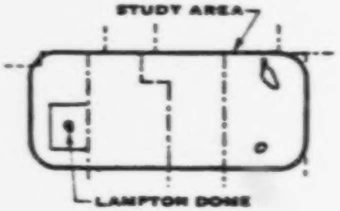

1.2
1.8
1.6
1.4
1.4
1.6
T3N
T2N
1.4
1.2
1.2
1.0
1.4
1.2
1.4
1.6
1.8
T3N
T2N
1.2
1.0
R18W
R17W
R17W
R16W

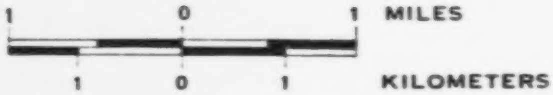
LEGEND

—— -3000 —— LINE OF EQUAL ELEVATION OF SALT, IN FEET. DATUM IS MEAN SEA LEVEL.

—— 1.2 —— LINES OF EQUAL RATIO OF EXTERIOR/INTERIOR DRAINAGE LINKS PER SQUARE MILE.

INTERVAL VARIABLE.


STUDY AREA
LAMPTON DOME


1
0
1
MILES
1
0
1
KILOMETERS

PREPARED	U.D.G	DATE	5-30-80
REVISED	[illegible]	DATE	[illegible]
REVISED		DATE	
APPROVED	[illegible]	DATE	[illegible]

T-1286-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
ISOLINES OF DRAINAGE RATIO

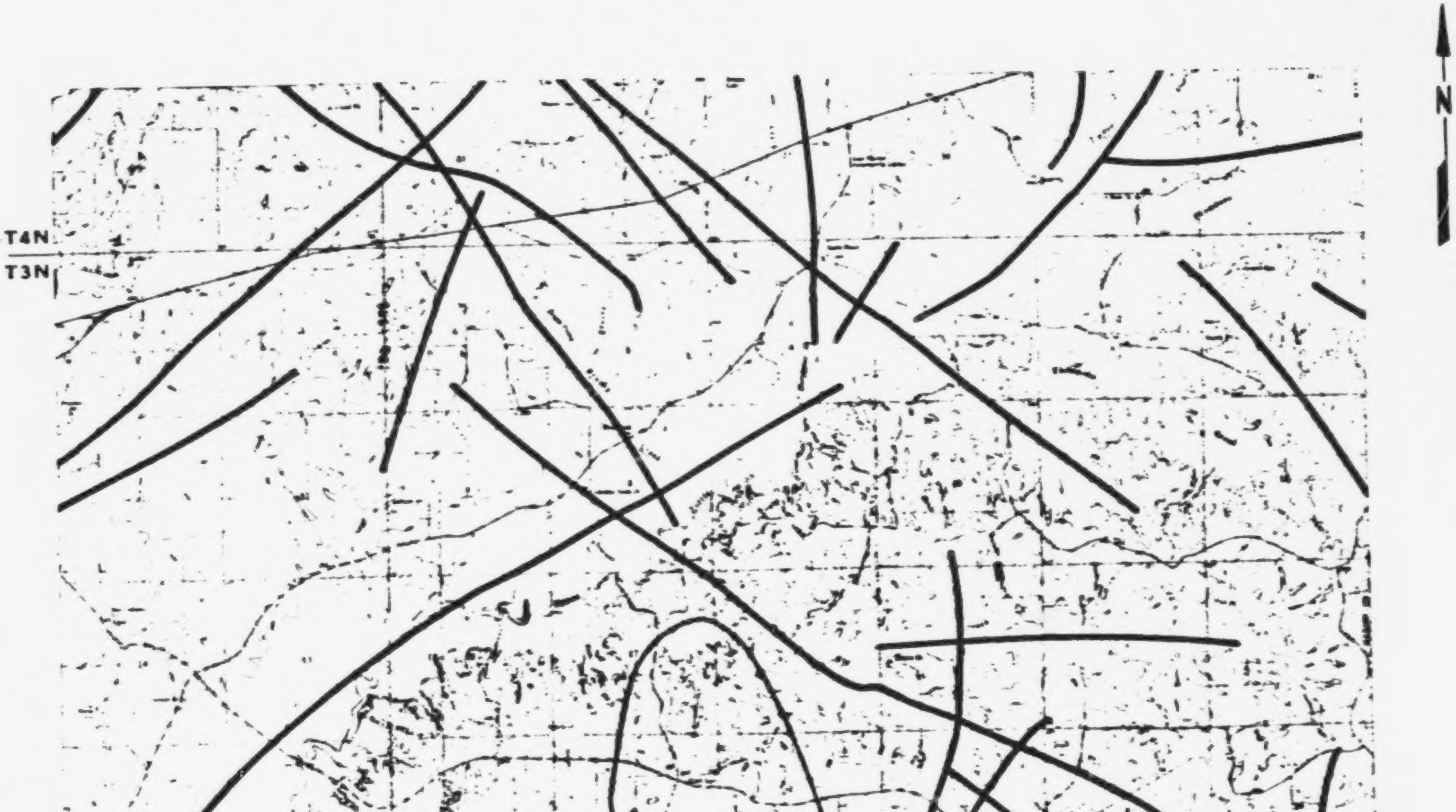
JOB NO. MV 9600

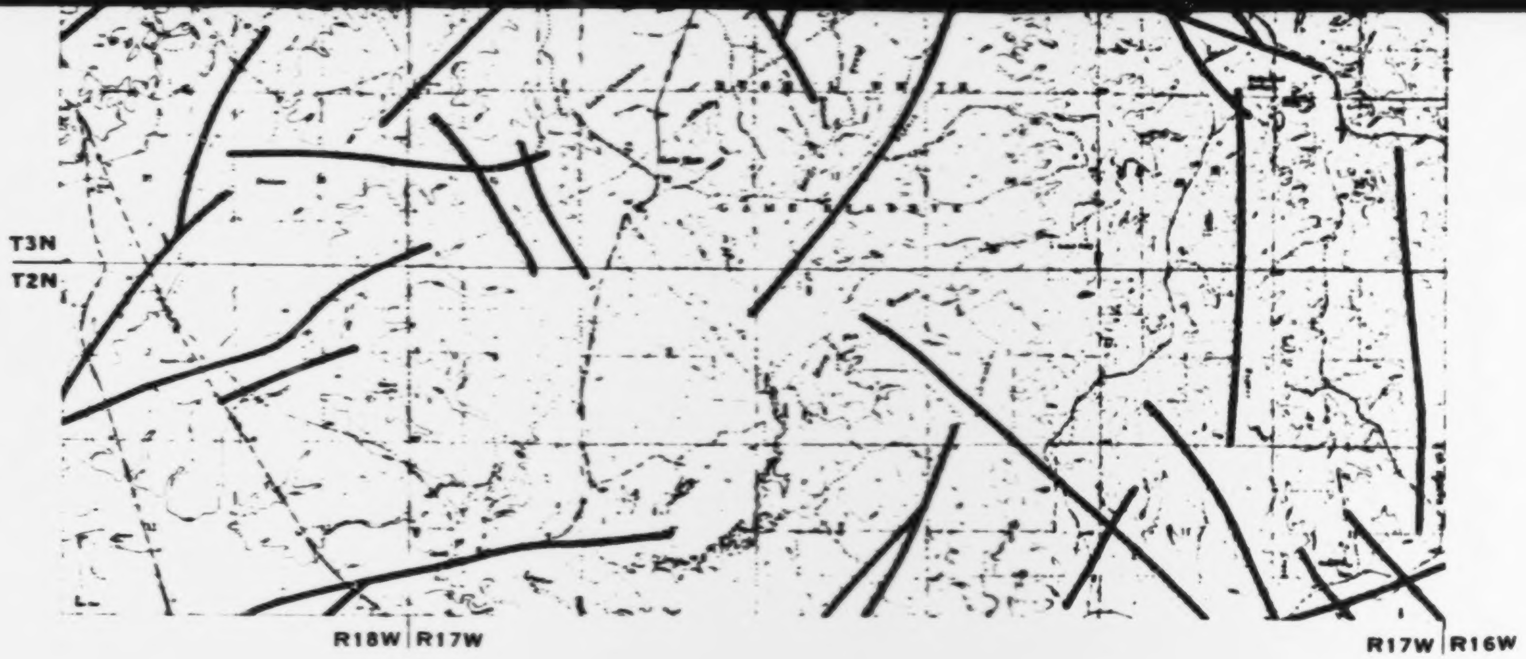
FIGURE 13-35

FIGURE 13-35

BEST DOCUMENT AVAILABLE

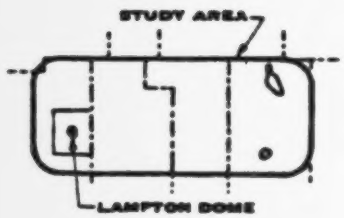
194


T4N
T3N
N
1000



LEGEND

-3000	LINE OF EQUAL ELEVATION OF SALT, IN FEET. DATUM IS MEAN SEA LEVEL.
▬	LINEAMENT FROM HIGH ALTITUDE COLOR INFRARED IMAGERY.



1 0 1 MILES

1 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET.

BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLE.

194A

FIGURE 13-36

PREPARED JDG. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1287-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

LAMPTON DOME

LINEAMENT MAP

JOB NO. MV9600

FIGURE 13-36

BEST DOCUMENT AVAILABLE

13.2.2.2 Stratigraphy: The stratigraphic section investigated in the Lampton Dome area includes all beds younger than the Upper Cretaceous Selma Group. Stratigraphic relationships of the formations are shown on the Lampton Dome Stratigraphic Chart (Table 13-2). The geologic sections in Figures 13-29 and 13-31 depict the relationships of the geologic units to each other and to the dome. Figures 13-27 and 13-30 show the locations of these sections.

Lithologic and stratigraphic correlations are based on petrologic and paleontologic analyses of drill cuttings and sidewall cores, integrated with data from geophysical logs from Area Characterization Well DOE MH-8A Masonite, which was drilled under the direction of LETCo in 1979. Geophysical logs and sidewall core descriptions obtained from oil and sulfur exploratory wells were used to supplement lithologic descriptions and stratigraphic correlations. The data collection locations and types of data used in the analyses are shown in Figures 13-24 and 13-25.

13.2.2.2.1 Stratigraphic Analysis - The formations in the Lampton Dome area are lithologically similar to those of the study area, although some variations occur in the Winona, Cockfield, Bucatunna, and Chickasawhay Formations. Locally, the Winona Formation contains more lime, while the Cockfield Formation contains less lime and more clay and shale. The Bucatunna Formation contains more clay in the near-dome area than elsewhere in the study area. The Chickasawhay Formation, which consists of clay, sand and sandstone in the near-dome area, reflects a western facies different from that described by May (1974) for Wayne County.

BEST DOCUMENT AVAILABLE

AF 12238A

SYSTEM	SERIES	GROUP OR STAGE	FORMATION	AGE MYBP	THICKNESS (FEET) STUDY AREA	THICKNESS (FEET) LAMPTON DOME	LAMPTON DOME LITHOLOGY
QUATERNARY	RECENT		ALLUVIUM		0 - 125	—	Clays, sands, and gravels.
	PLIO-PLEISTOCENE		CITRONELLE	1.8	0 - 215	—	Silty, clayey sands grading into basal gravel beds.
TERTIARY	MIOCENE		HATTIESBURG AND CATAHOULA UNDIFF.	22.5	349 - 1991	349 - 1991	Locally sandy or carbonaceous clay and siltstone, very fine to very coarse grained sand, quartz and chert gravel, shaly, micaceous mudstone, and chalky limestone. Includes the *Heterostegina* zone, a biofacies zone composed of limestone and sand with minor amounts of clay.
	OLIGOCENE		CHICKASAWHAY		46-215	66-114	Clays, very fine to very coarse grained sands, and fine to coarse grained limy sandstones.
		VICKSBURG	BUCATUNNA		11-91	15-46	Clays with minor sands, sandstones, and limestones.
			VICKSBURG LIMESTONES UNDIFF.		61-240	120-240	Chalky, glauconitic, locally sandy and clayey limestones.
			RED BLUFF	38	15-123	32-66	Limy clays, chalky, sandy, glauconitic limestones, and very fine and coarse grained sands.
	EOCENE	JACKSON	YAZOO		113-330	140-240	Locally calcareous clays and shales, silty, glauconitic mudstones and limestones.
			MOODYS BRANCH	42	10-37	9 - 34	Calcarenitic, glauconitic, chalky limestone, fine to coarse grained, glauconitic sands, and sandy clay or shale.
		CLAIBORNE	COCKFIELD		76-225	80 - 180	Limy and locally carbonaceous clays interbedded with glauconitic, limy, silty shales and mudstones, and chalky, argillaceous, sandy, and glauconitic limestones.
			COOK MOUNTAIN	44.5	112-260	130-195	Shale, sand and locally chalky, glauconitic, calcarenitic limestone.
			KOSCIUSKO (SPARTA)	48	121-370	184-280	Glauconitic clays and silty, glauconitic slightly limy shales and mudstones with argillaceous limestone and sand found locally.
			ZILPHA		45-220	128-208	Limy, glauconitic clays, silty, limy, glauconitic shales, and traces of lignite.
			WINONA		22-62	22-35	Very glauconitic and argillaceous, chalky limestones to limy clay and shale.
			TALLAHATTA	50	127-500	127-195	Interbedded glauconitic clays, limy, silty, glauconitic shales and mudstones, and locally chalky limestones.
	?	WILCOX	WILCOX GROUP UNDIFF.	53.5	1,366 - 4,955	1,342 - 2,324	Locally calcareous clays, sand, sandstone, siltstone, and limestone with traces of carbonaceous material throughout.
	PALEOCENE	MIDWAY	PORTERS CREEK		468 - 1,195	860 - 1,135	Shales interbedded with minor clays, limes, lignites, and sands with an overlying sand and clay unit.
			CLAYTON		0 - 37	12-25	Limy clays.

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOME
STRATIGRAPHIC CHART

JOB NO. MV9600 TABLE 13-2

[redacted]

196

The strata dip away from the dome (Figures 13-29 and 13-31). The formations below the Wilcox Group have especially steep dips, perhaps resulting from piercement activity. Four of the study area structure contour maps (Figures 12-15 through 12-18) show a relatively small structural depression on the southwest side of Lampton Dome on the tops of the Porters Creek, Kosciusko, and Cook Mountain Formations, as well as the Wilcox Group. Each of these formations show some thickening in the area of the structural depression, which may be a rim syncline related to growth of the dome during the early Tertiary.

13.2.2.3 Structure: Lampton Dome, a shallow piercement dome, penetrates Jurassic through late Tertiary sediments. Structural contour maps on eight Late Cretaceous to late Tertiary Formations (Figures 12-13 through 12-20) indicate that the regional dip is generally westerly, with local southwesterly and northwesterly variations. The general regional dip is modified locally by uplifts related to piercement activity. Growth of the Lampton salt stock produced approximately 610 meters (2,000 ft) of structural closure on the top of the Lower Tuscaloosa. The amount of closure decreases upward to less than 61 meters (200 ft) on the top of the Vicksburg beds.

The extent of the area affected by salt withdrawal (rim syncline) is not well defined on some of the contoured horizons because of a lack of well control in the near-dome area. However, a prominent structural low, which has about 30 meters (100 ft) of closure on the top of the Porters Creek, Wilcox, Kosciusko, and

Cook Mountain Formations, trends northwesterly on the southwestern flank of the dome. This trough is also apparent as a closed depression with less than 30 meters (100 ft) of closure. A second basinal area is interpreted to be present on the Porters Creek Formation, southeast of the dome (Figure 12-15). This feature, which is about midway between Lampton and Tatum Domes, has less than 30 meters (100 ft) of closure and has not been mapped on any other horizons.

The strata immediately adjacent to the dome are upturned toward the salt stock (Figures 13-29 and 13-31). The upturning is most pronounced on the top of the Lower Tuscaloosa, which has about 762 meters (2,500 ft) of structural relief within 5 km (3 mi) of the salt stock (Figure 13-31).

Several faults interpreted from well data extend along the southeastern flank of the salt dome for approximately 2.4 km (1.5 mi). Although faults have been identified at the tops of the Lower Tuscaloosa, Selma, and Wilcox units, there are insufficient data to determine their exact extent. A detailed discussion of the faulting near the dome appears in Section 12.2.3.4.5.1.

Anderson and others (1973) suggest that diapiric clay is in contact with Lampton Dome. Well data from the eastern flank of the dome indicate the presence of a sheath of anhydrite-rich material, up to 61 meters (200 ft) thick, extending down the side of the dome to approximately -2,286 meters (-7,500 ft) MSL.

13.2.3 MINERAL RESOURCES: Proven mineral resources in the Lampton Dome area are limited to minor gravel production from open pits. However, some of the deep strata in the vicinity of the dome may contain prospective oil reserves. Any petroleum production within 3 km (2 mi) of the dome flanks will probably be from less than 202 hectares (500 acres) and it will produce no more than 79,500 m^3 (500,000 bbl) of combined oil and gas equivalent (Murray, 1979). Clay is present in potentially commercial quantities; however, clay is not currently being produced in the near-dome area.

13.2.3.1 Hydrocarbons: Petroleum exploration in the Lampton Dome area began in 1934 and continued at least through 1977. No production has been developed in the immediate vicinity of the dome nor in nearby areas. The closest production is from Hub Field about 8 km (5 mi) to the southwest, and at Baxterville Field, about 13 km (8 mi) to southeast (Figure 12-33). A discussion of Hub Field may be found in Sections 12.2.3.4.3 and 12.3.1.1. Baxterville Field is described in Sections 12.2.3.4.4 and 12.3.1.2. While all strata older than Miocene may optimistically be considered potentially prospective, oil and gas potential at Lampton Dome is considered speculative to poor (Murray, 1979). However, extensive faulting on the southeastern flank of Lampton Dome may prove to be a trap for petroleum accumulation.

13.2.3.2 Mineral Resource Potential: Lampton Dome has undergone extensive sulfur exploration. Ten exploratory wells were drilled in the near-dome area between 1940 and 1950 (Table 12-2). However, no sulfur production has been established at this dome, nor at any other dome in the three interior salt basins (Murray, 1979). Murray (1979) investigated the resource potential of many other commodities which could be extracted from an area within 3 km (2 mi) of the dome flanks. In this study, only four commodities or activities are rated better than a fair potential for development. They are:

(1) Brining, good to excellent

(2) Recreation and general use, good to excellent

(3) Underground storage, good to excellent

(4) Agricultural products and farming, fair to good.

Other commodities considered to have, at best, a fair potential for development are:

(1) Carbon dioxide

(2) Construction material

(3) Geothermal and geopressured materials (used locally and developed during production of some other commodity)

(4) Heavy minerals

(5) Hydrogen sulfide

(6) Road materials

(7) Sand and gravel.

However, in the context of current economics and marketability, none of the known commodities are considered to have an encouraging potential.

13.3 RICHTON DOME

Richton Dome, the largest and shallowest piercement salt dome in the Mississippi Salt Basin (Karges, 1975), is centered around

Sections 22, 26, 27 and 35 of T5N, R10W in north-central Perry County, Mississippi (Figure 13-37). An arbitrary near-dome area, 13 km (8 mi) in an east-west direction and 16 km (10 mi) north-south, was chosen for characterization and comparison to the study area. For more precise reference, the term supradomal area was chosen to designate that portion of the dome area overlying and enclosed by a surface projection of the -914-meter (-3000 ft)-MSL salt dome contour. The study techniques and data utilized to characterize the geology of the near-dome area are discussed in Chapter 2 (Volume I). The specific types of data used and data collection locations are shown in Figures 12-10, 13-38 and 13-39 and Table 12-2.

13.3.1 DOME GEOMETRY AND COMPOSITION: Interpretation of gravity data collected during Area Characterization indicates that Richton Dome is situated on top of a long, northwesterly-trending salt ridge (Figures 13-37 and 13-40). The Richton salt stock is elliptically shaped, with its long axis parallel to that of the underlying salt anticline.

The gravity model of the dome indicates that the salt stock is the same width as the salt anticline from -6,096 to -1,829 meters (-20,000 to -6,000 ft) MSL. The salt stock is approximately 13 km (8 mi) long by 3 km (2 mi) wide at -1,829 meters (-6,000 ft) MSL. Between 4,877 and 1,219 meters (-16,000 and -4,000 ft) MSL the salt column flares outward on the western flank, forming an extensive bulge or overhang. This side of the dome forms a sheer salt wall from -1,219 to -610 meters (-4,000 to -2,000 ft) MSL. Above -610 meters (-2,000 ft) MSL the dome is convex and the length of the salt stock decreases. At -305 meters (-1,000 ft) MSL the salt stock is approximately 8 km (5 mi) long by 3 km (2 mi) wide.

A similar geometry developed on the eastern flank of the dome with an overhang extending up from -4,877 to ~-1,219 meters (-16,000 to ~-4,000 ft) MSL on the southern half of the dome. On the northeastern flank of the dome the overhang extends from approximately -4,877 to -610 meters (-16,000 to -2,000 ft) MSL (Figures 13-37, 13-42, 13-43, and 13-45).

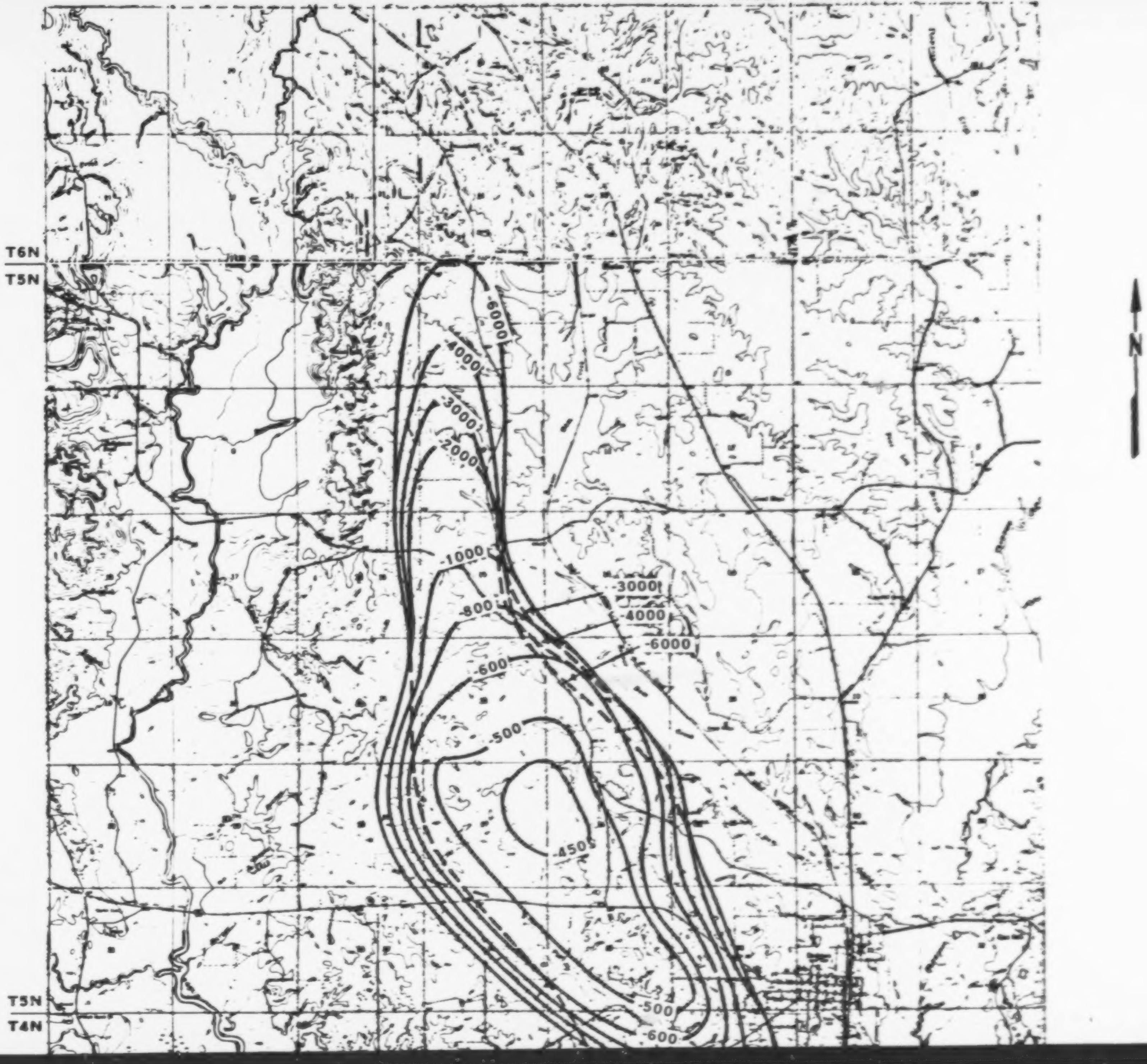
The following table summarizes the planimetered area of Richton Dome at three levels (Figure 13-39).

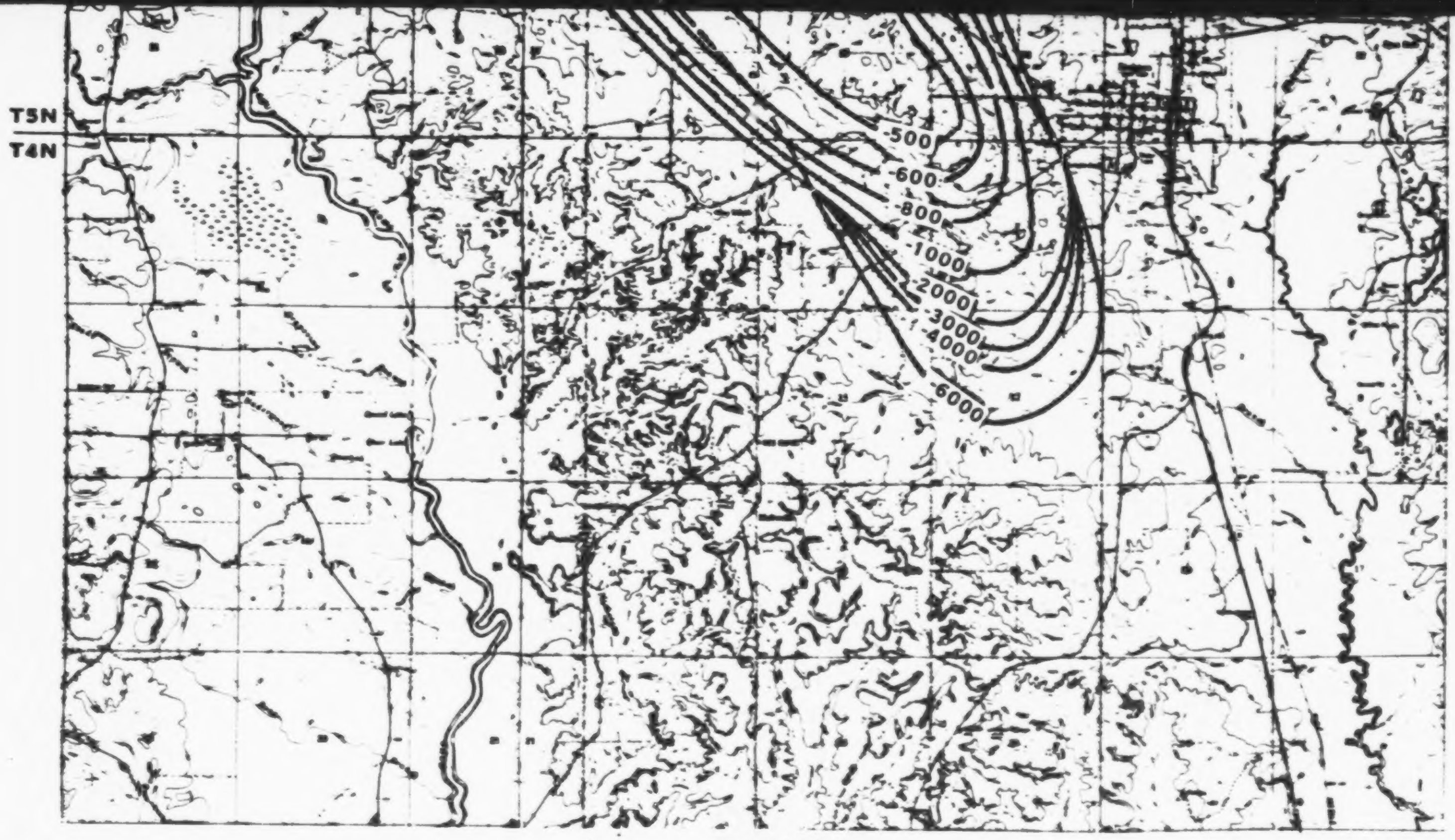
Elevation (feet MSL)	Depth Range (feet)*	Area (acres)**
-2000	2170 to 2290	5585
-2500	2670 to 2790	5825
-3000	3170 to 3290	5847

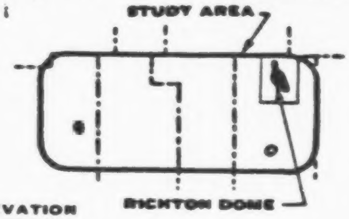
---

*To convert to meters, multiply by 0.3048.
**To convert to hectares, multiply by 0.4047.

Thirty unsuccessful sulfur test wells were drilled into caprock (Table 12-2), eight of which extended into salt. In these wells, the top of caprock ranged from depths of 151 to 268 meters (497 to 879 ft). One well, DOE MRIG-9 Masonite (Figure 12-43), drilled for this study, was extended into salt and encountered caprock at a depth of 169 meters (554 ft) and salt at a depth of


R10W
R9W
T6N
T5N
-6000
-4000
-3000
-2000
-1000
-800
-600
-500
-450
-3000
-4000
-6000
-500
-600
T5N
T4N
N





2034

LEGEND

——— -1000 — — — STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL VARIABLE. DATUM IS MEAN SEA LEVEL.

1 0 1 MILES

1 0 1 KILOMETERS

CONTOUR INTERVAL 10 FEET.

BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLE.

PREPARED J.D.G.	DATE 5-30-80
REVISED DPF	DATE 12/4/81
REVISED	DATE
APPROVED	DATE 6/10/80

T-1290-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

RICHTON DOME

TOPOGRAPHIC MAP WITH
STRUCTURE CONTOURS ON SALT

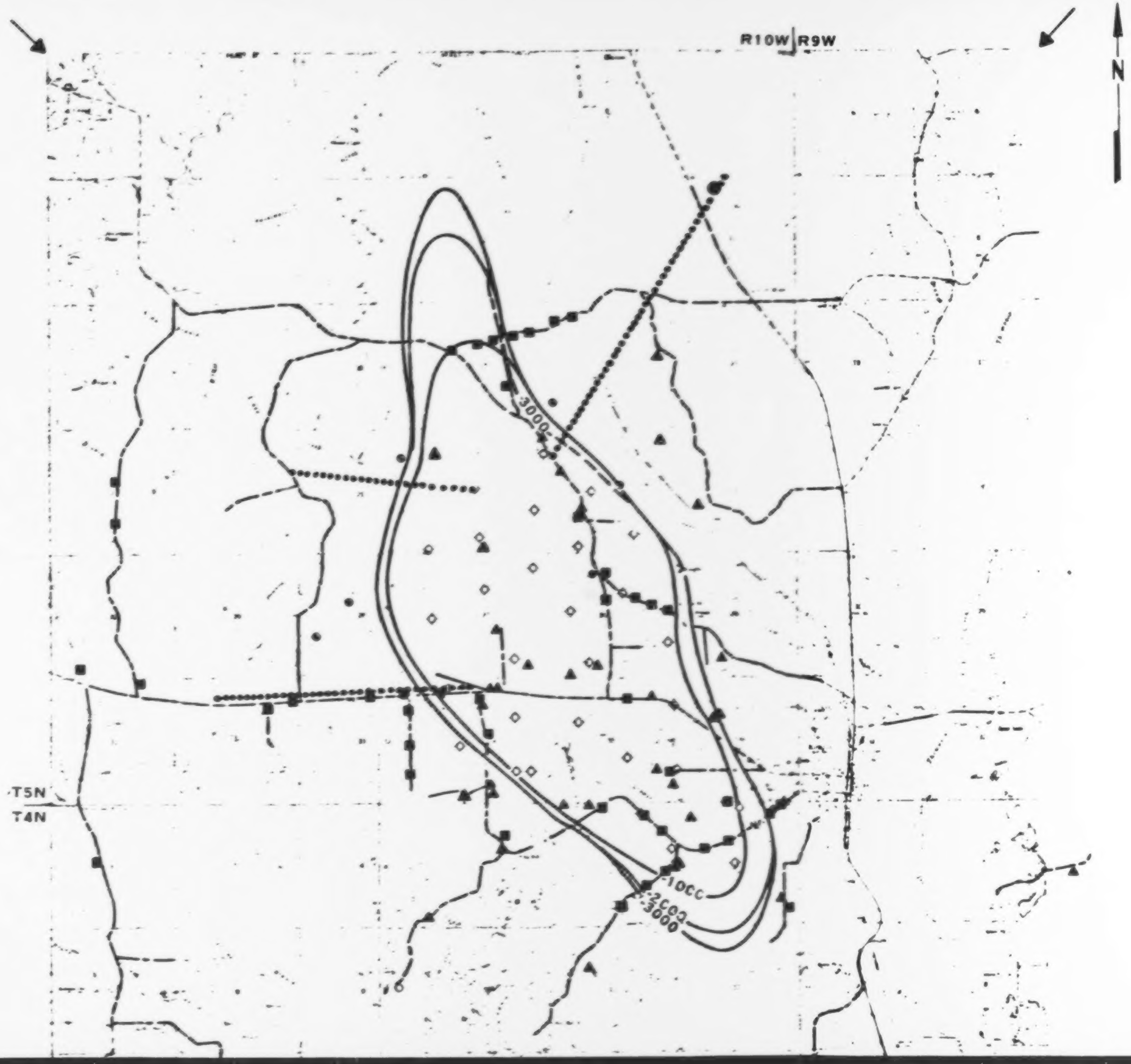
JOB NO. MV9600

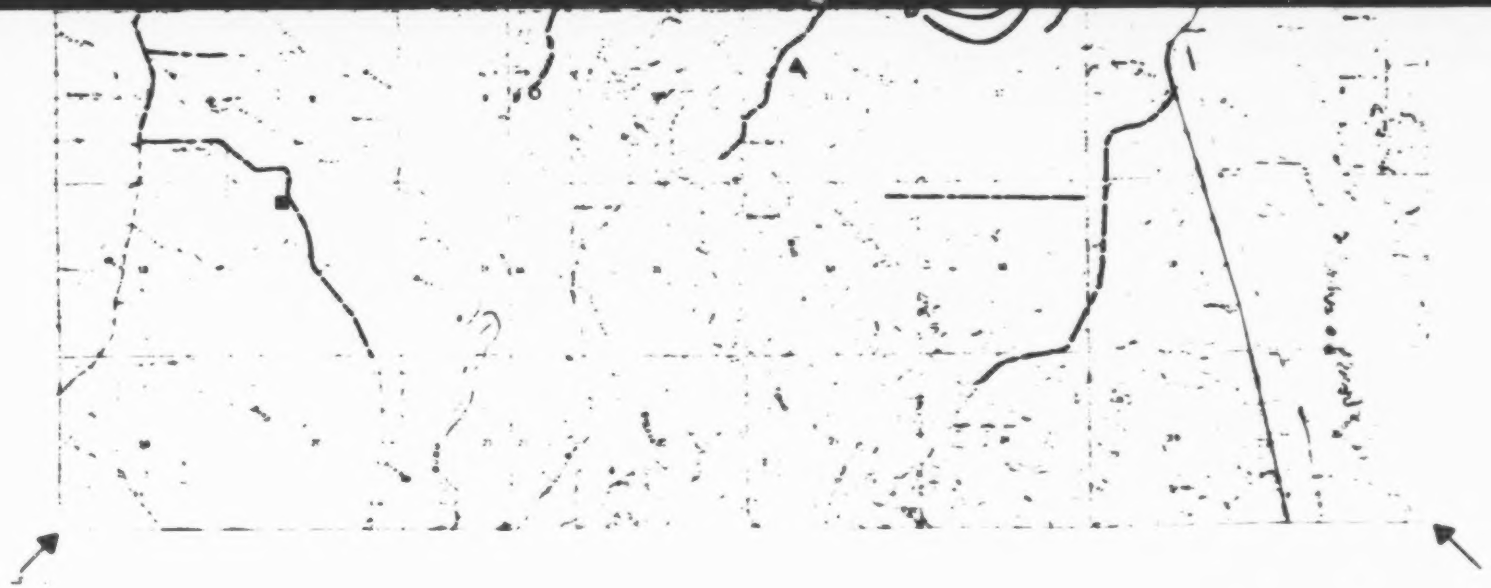
FIGURE 13-37

FIGURE 13-37

BEST DOCUMENT AVAILABLE

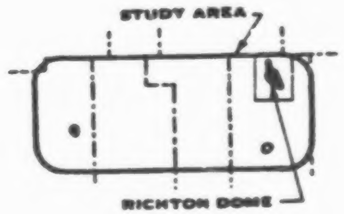
204


R10W
R9W
N
3000
T5N
T4N
1000
2000
3000



LEGEND

●	OIL OR GAS WELL
◇	SULPHUR TEST WELL
○	AREA CHARACTERIZATION HYDROLOGIC BORING
●	AREA CHARACTERIZATION GEOLOGIC BORING
◎	AREA CHARACTERIZATION SALT CORE BORING
▲	AREA CHARACTERIZATION SHALLOW BORING
—1000—	STRUCTURE CONTOUR - SHOWS ELEVATION OF TOP OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL 1000 FEET. DATUM IS MEAN SEA LEVEL.
— — —	GROUND LEVEL RESISTIVITY HORIZONTAL PROFILE
• • • • • • • • •	HIGH RESOLUTION SEISMIC REFLECTION LINE
■	GROUND LEVEL RESISTIVITY VERTICAL SOUNDING
↗	LIMIT OF TERRACE MAPPING PROGRAM



1
0
1
MILES
1
0
1
KILOMETERS

CONTOUR INTERVAL 10 FEET.

BASE FROM U.S. GEOLOGICAL SURVEY
1:24,000 QUADRANGLE.

2040

BEST DOCUMENT AVAILABLE

PREPARED	JDG	DATE	9-15-80
REVISED	CAG	DATE	12/2/81
REVISED		DATE	
APPROVED		DATE	8/20/80

T-1291-2

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
DATA UTILIZED IN ANALYSIS

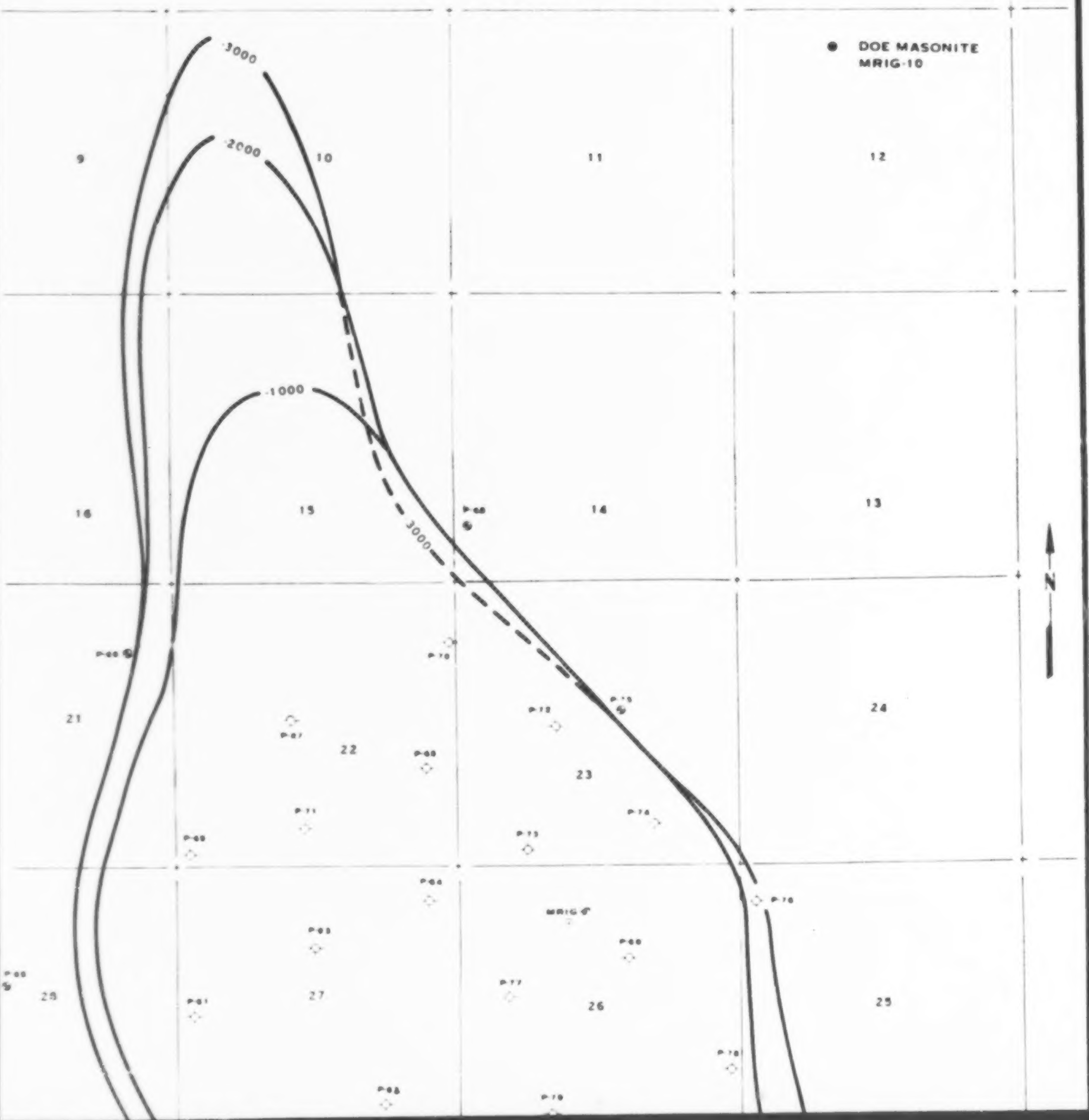
JOB NO. MV9600

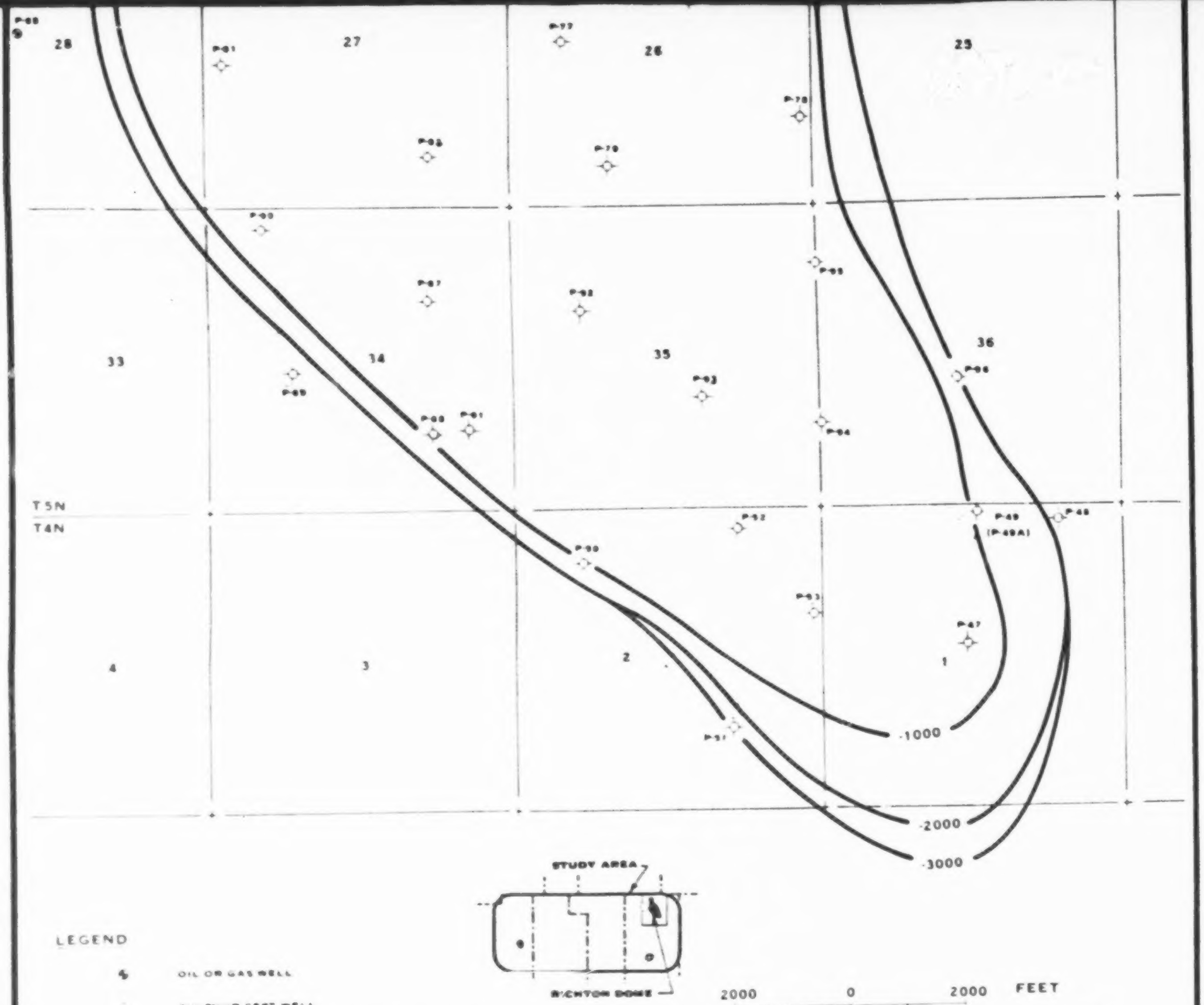
FIGURE 13-38

BEST DOCUMENT AVAILABLE

205

SALT CONTOUR (ELEVATION IN FEET MSL)	TOTAL AREA (ACRES)
-2000	5585
-2500	5825
-3000	5847


R10W R9W
● DOE MASONITE MRIG-10
-3000
-2000
-1000
3000
9
10
11
12
16
15
14
13
21
22
23
24
28
27
26
25
MRIG 6
N


28
27
26
25
33
34
35
36
4
3
2
1
T5N
T4N
P-47
P-48
P-49
(P-49A)
P-51
P-52
P-53
-1000
-2000
-3000
STUDY AREA
RICHTON DOME

LEGEND

✦	OIL OR GAS WELL
✧	SULPHUR TEST WELL
●	AREA CHARACTERIZATION GEOLOGIC BORING
○	AREA CHARACTERIZATION SALT CORE BORING
—— 1000 – –	LINE OF EQUAL ELEVATION OF SALT DASHED BENEATH SALT OVERHANG INTERVAL 1000 FEET DATUM IS MEAN SEA LEVEL

2000 0 2000 FEET

0.5 0 0.5 KILOMETERS

AREA DETERMINED BY PLANIMETER METHOD

WELL KEY IN APPENDIX TABLE A 4.1

PREPARED ~~RDG~~ DATE 5-30-80
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE 8-1-80

T-1292-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
WELL LOCATION MAP

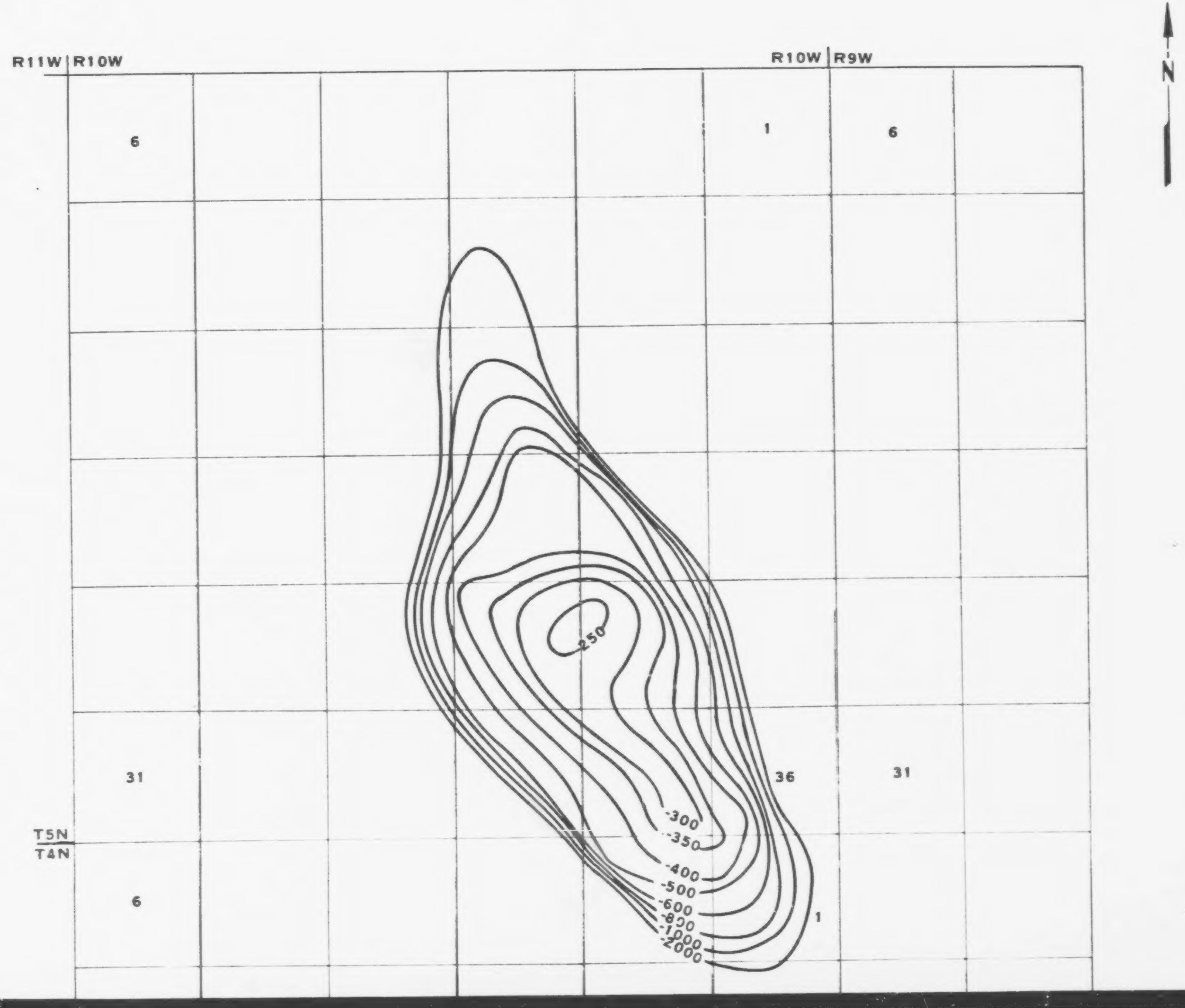
JOB NO MV9600 FIGURE 13-39

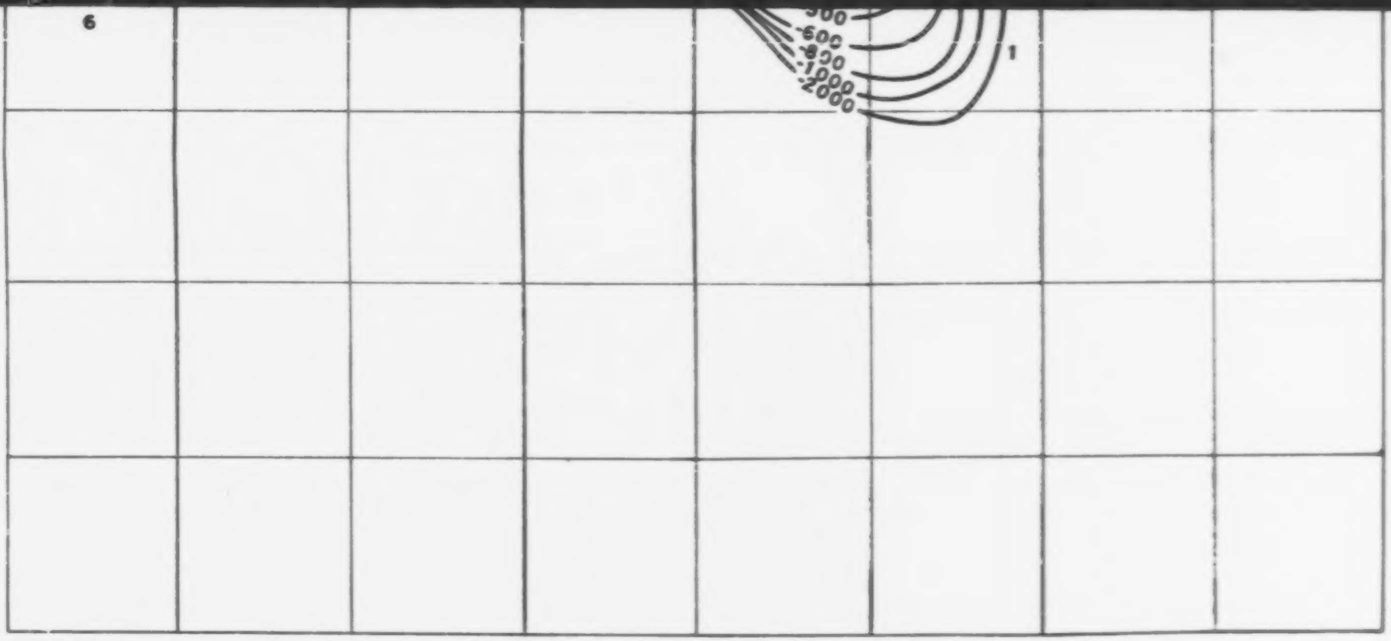
FIGURE 13-39

BEST DOCUMENT AVAILABLE

205A

BEST DOCUMENT AVAILABLE

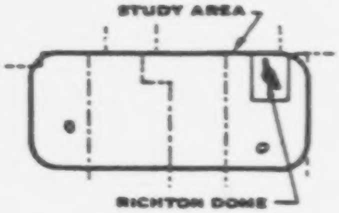

R11W
R10W
R10W
R9W
N
6
1
6
250
31
36
31
T5N
T4N
6
-300
-350
-400
-500
-600
-800
-1000
-2000
1


6
00
-600
-800
-1000
-2000
1

LEGEND

——-1000—— STRUCTURE CONTOUR - SHOWS ELEVATION IN FEET OF TOP OF CAPROCK. INTERVAL VARIABLE. DATUM IS MEAN SEA LEVEL.

1
0
1
MILES
1
0
1
KILOMETERS


STUDY AREA
RICHTON DOME

206A

FIGURE 13-40

PREPARED J.D.G. DATE 8-15-80
REVISED DATE 12/4/81
REVISED DATE
APPROVED DATE

T-1452-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

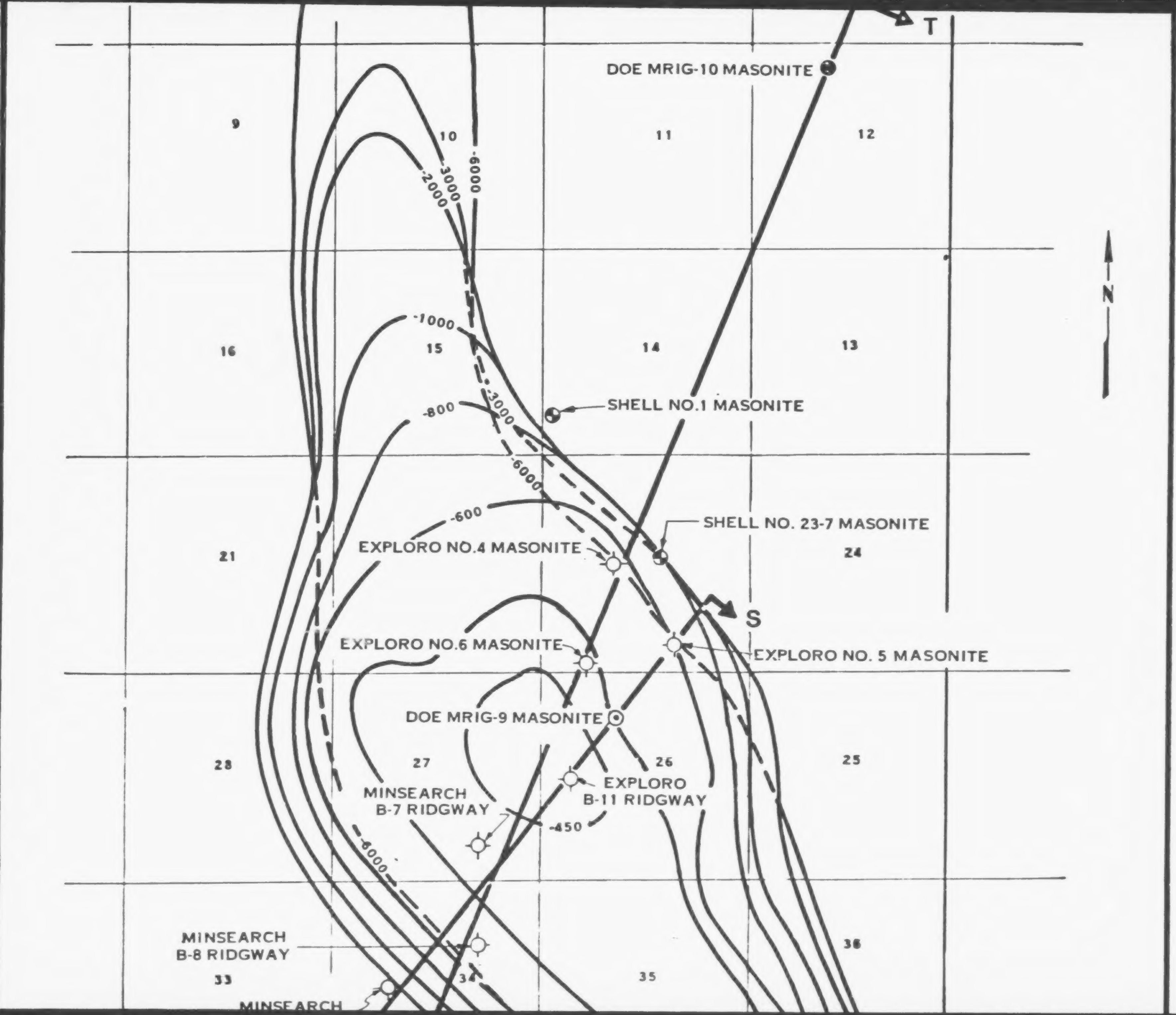
MISSISSIPPI STUDY AREA
RICHTON DOME
STRUCTURE CONTOUR MAP OF TOP OF CAPROCK

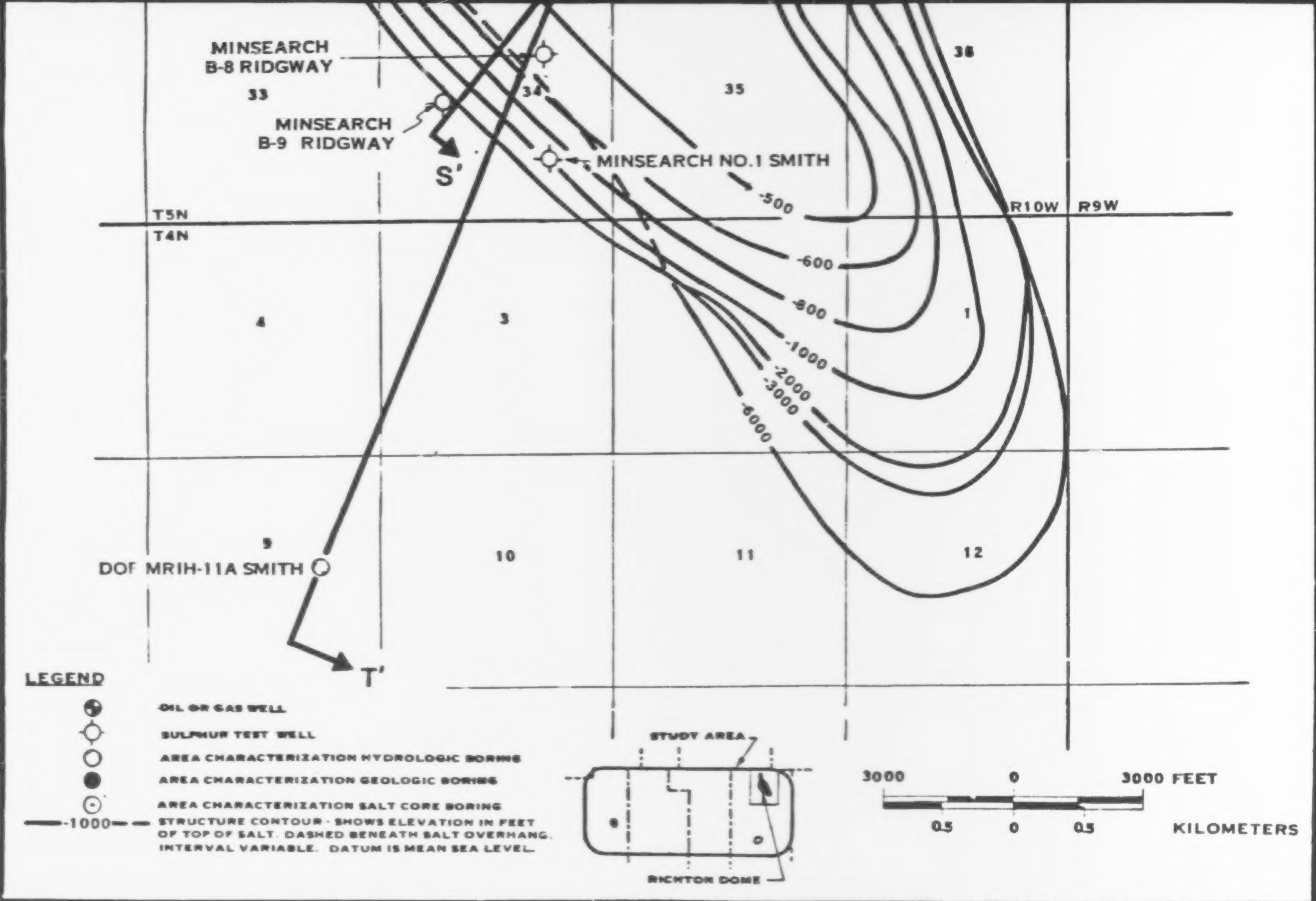
JOB NO. MV9600

FIGURE 13-40

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE


T
DOE MRIG-10 MASONITE
9
10
11
12
-3000
-2000
-6000
N
16
15
14
13
-1000
-800
SHELL NO.1 MASONITE
-3000
-6000
-600
SHELL NO. 23-7 MASONITE
EXPLORO NO.4 MASONITE
21
24
S
EXPLORO NO.6 MASONITE
EXPLORO NO. 5 MASONITE
DOE MRIG-9 MASONITE
28
27
26
25
EXPLORO B-11 RIDGWAY
MINSEARCH B-7 RIDGWAY
-450
-6000
MINSEARCH B-8 RIDGWAY
33
34
35
36
MINSEARCH


MINSEARCH
B-8 RIDGWAY
33
34
35
36
MINSEARCH
B-9 RIDGWAY
S'
MINSEARCH NO.1 SMITH
-500
T5N
T4N
R10W
R9W
-600
-800
-1000
-2000
-3000
-5000
4
3
1
9
10
11
12
DOE MRIH-11A SMITH
T'
LEGEND
OIL OR GAS WELL
SULPHUR TEST WELL
AREA CHARACTERIZATION HYDROLOGIC BORING
AREA CHARACTERIZATION GEOLOGIC BORING
AREA CHARACTERIZATION SALT CORE BORING
-1000- STRUCTURE CONTOUR - SHOWS ELEVATION IN FEET OF TOP OF SALT. DASHED BENEATH SALT OVERHANG. INTERVAL VARIABLE. DATUM IS MEAN SEA LEVEL.
STUDY AREA
RICHTON DOME
3000
0
3000 FEET
0.5
0
0.5
KILOMETERS

207A

FIGURE 13-41

PREPARED J.D.G. DATE 5-30-80
REVISED D.M.T. DATE 12-2-81
REVISED ______ DATE ______
APPROVED ______ DATE 8/10/81

T-1293-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

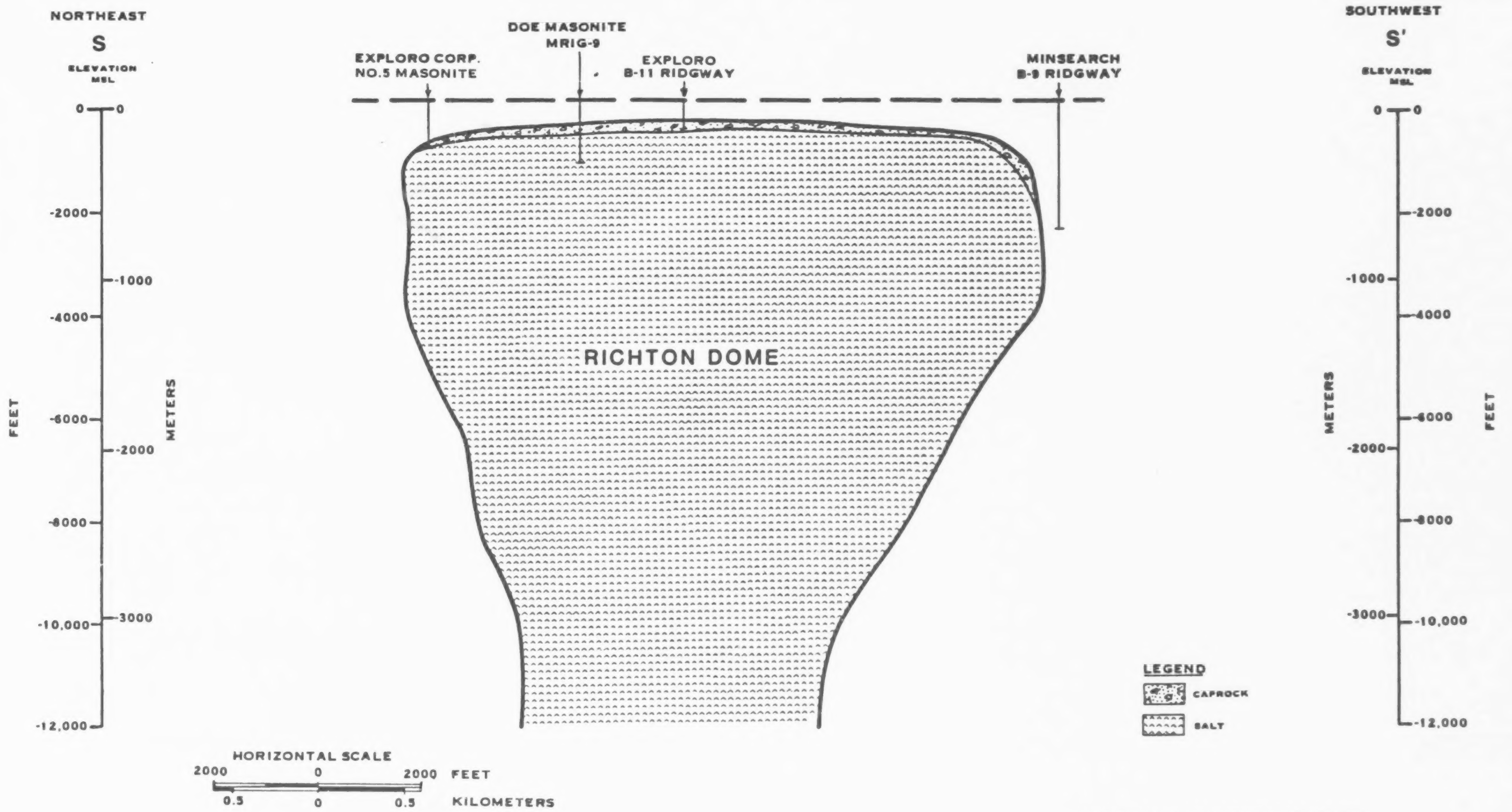
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
LOCATION MAP
GEOLOGIC SECTIONS S-S' AND T-T'

JOB NO. MV 9600

FIGURE 13-41

BEST DOCUMENT AVAILABLE


NORTHEAST
S
ELEVATION MSL
DOE MASONITE MRIG-9
EXPLORO CORP. NO.5 MASONITE
EXPLORO B-11 RIDGWAY
MINSEARCH B-9 RIDGWAY
SOUTHWEST
S'
ELEVATION MSL
0
-2000
-4000
-6000
-8000
-10,000
-12,000
FEET
0
-1000
-2000
-3000
METERS
RICHTON DOME
LEGEND
CAPROCK
SALT
HORIZONTAL SCALE
2000 0 2000 FEET
0.5 0 0.5 KILOMETERS

SEE FIGURE 13-41 FOR CROSS-SECTION LOCATION

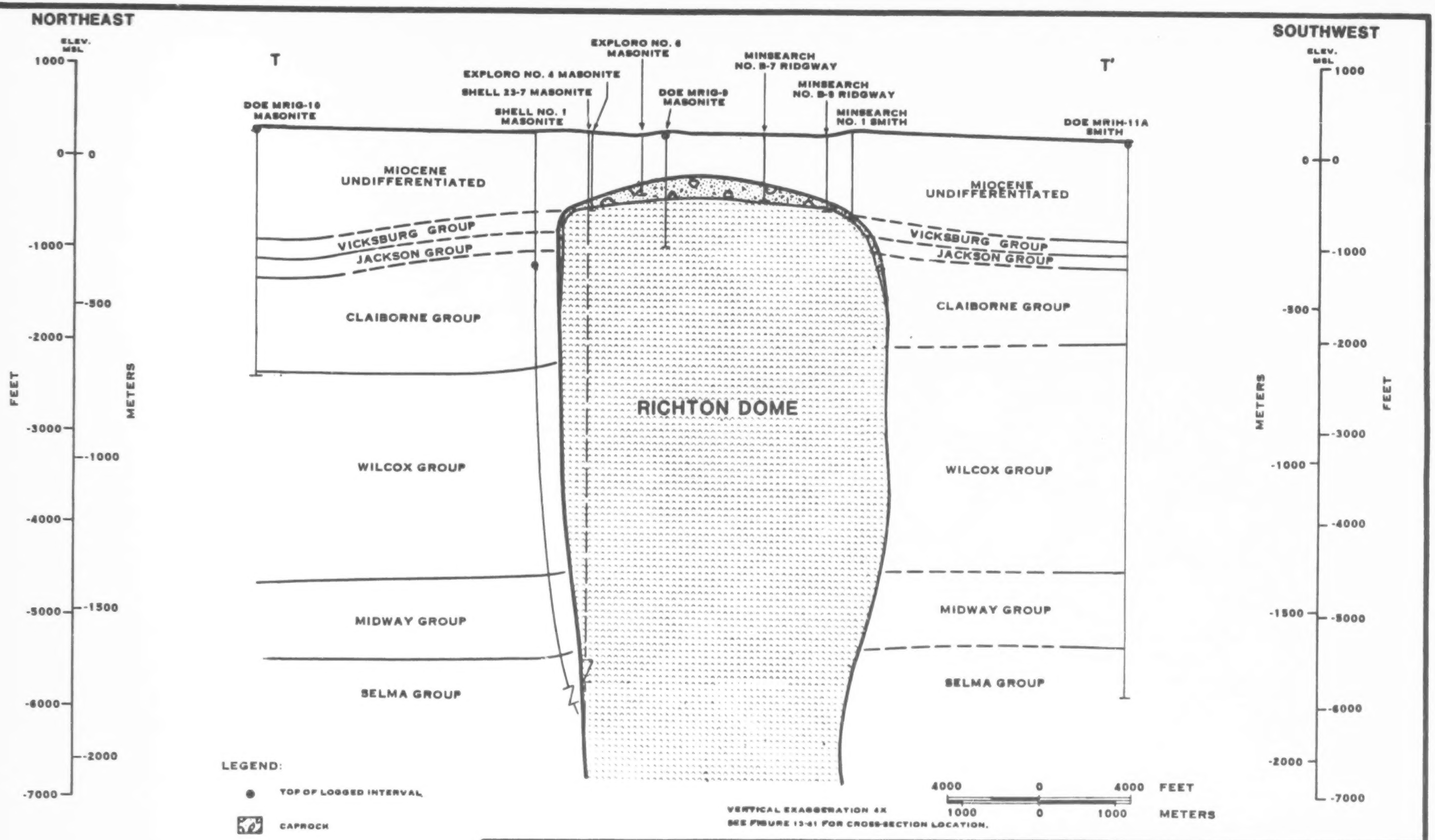
PREPARED J.D.G. DATE 12-4-81
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED DJP DATE 12/4/81
T-1430-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
TRUE SCALE DOME SECTION S-S'

JOB NO. MV8500 FIGURE 13-42

BEST DOCUMENT AVAILABLE


NORTHEAST
SOUTHWEST
T
T'
ELEV. MSL
FEET
METERS
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-500
-1000
-1500
-2000
EXPLORO NO. 6 MASONITE
MINSEARCH NO. B-7 RIDGWAY
EXPLORO NO. 4 MASONITE
SHELL 23-7 MASONITE
DOE MRIG-9 MASONITE
MINSEARCH NO. B-9 RIDGWAY
DOE MRIG-10 MASONITE
SHELL NO. 1 MASONITE
MINSEARCH NO. 1 SMITH
DOE MRIH-11A SMITH
MIOCENE UNDIFFERENTIATED
VICKSBURG GROUP
JACKSON GROUP
CLAIBORNE GROUP
RICHTON DOME
WILCOX GROUP
MIDWAY GROUP
SELMA GROUP
LEGEND:
● TOP OF LOGGED INTERVAL
CAPROCK
SALT
VERTICAL EXAGGERATION 4X
SEE FIGURE 13-41 FOR CROSS-SECTION LOCATION.
4000 0 4000 FEET
1000 0 1000 METERS

PREPARED JDG. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED DEP DATE 12/4/81

T-1294-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

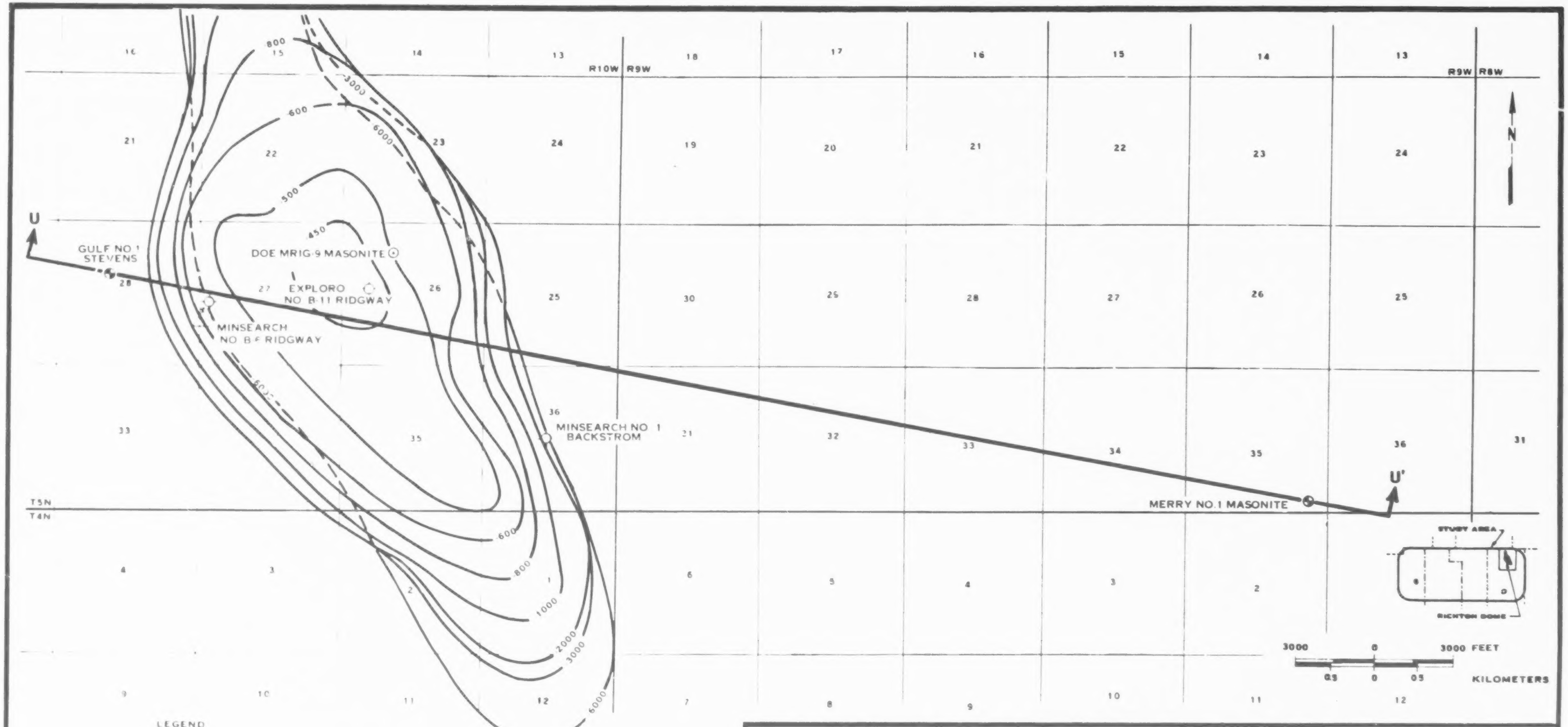
MISSISSIPPI STUDY AREA
RICHTON DOME
GEOLOGIC SECTION T - T'

JOB NO. MV9600

FIGURE 13-43

BEST DOCUMENT AVAILABLE

209


R10W | R9W
R9W | R8W
T5N
T4N
N
U
U'
GULF NO 1 STEVENS
DOE MRIG-9 MASONITE
EXPLORO NO B-11 RIDGWAY
MINSEARCH NO B-F RIDGWAY
MINSEARCH NO 1 BACKSTROM
MERRY NO 1 MASONITE
800
600
500
450
3000
6000
600
800
1000
2000
3000
6000
16
15
14
13
18
17
16
15
14
13
21
22
23
24
19
20
21
22
23
24
28
27
26
25
30
25
28
27
26
25
33
35
36
31
32
33
34
35
36
31
4
3
2
1
6
5
4
3
2
9
10
11
12
7
8
9
10
11
12
STUDY AREA
RICHTON DOME
3000 0 3000 FEET
0.5 0 0.5 KILOMETERS
LEGEND
OIL OR GAS WELL
SULPHUR TEST WELL
AREA CHARACTERIZATION SALT CORE BORING
-1000 STRUCTURE CONTOUR SHOWS ELEVATION IN FEET OF TOP OF SALT DASHED BENEATH SALT OVERHANG INTERVAL VARIABLE DATUM IS MEAN SEA LEVEL

PREPARED	J D G	DATE	5-30-80
REVISED		DATE	
REVISED		DATE	
APPROVED		DATE	

T 1295-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM

GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

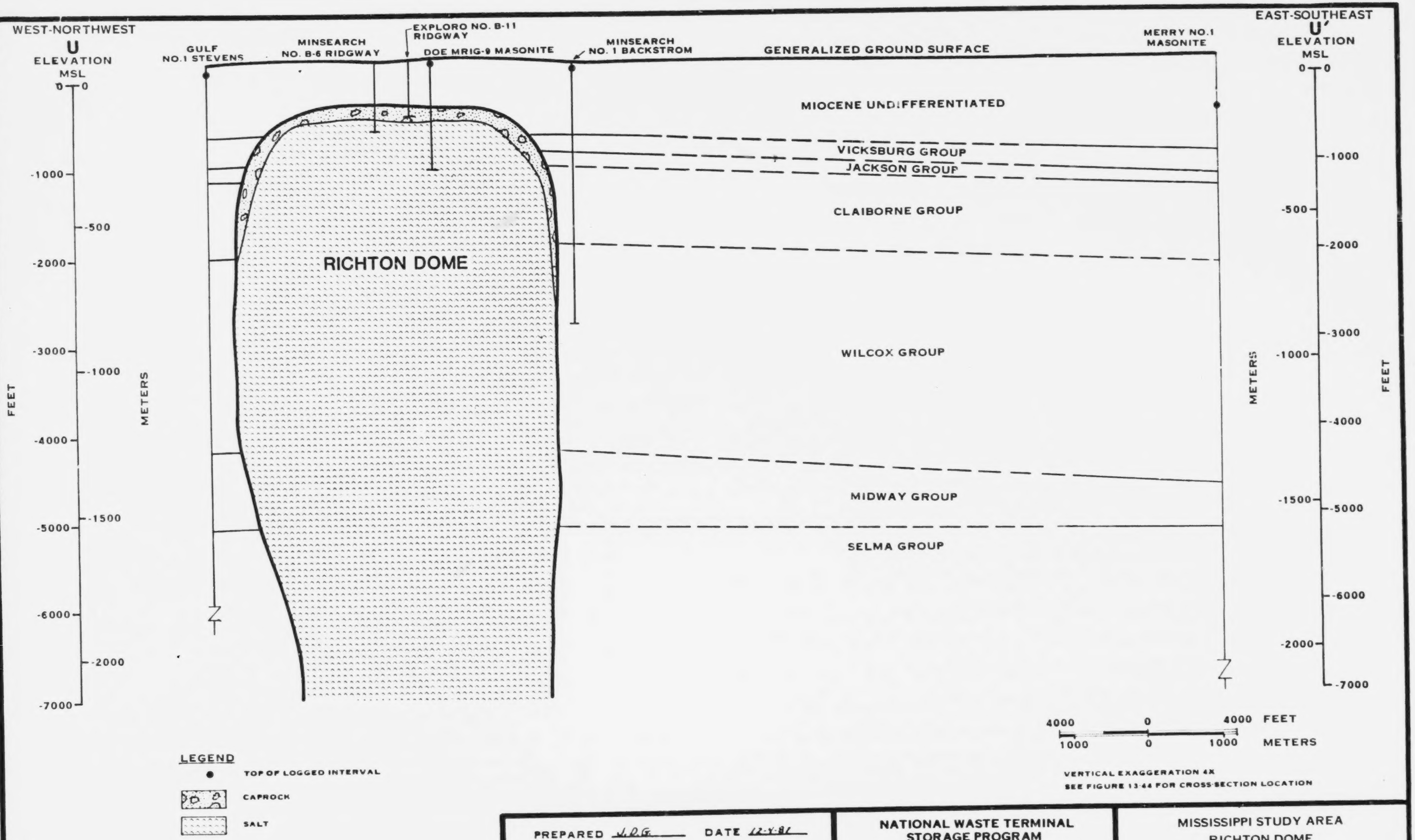
RICHTON DOME

LOCATION MAP
GEOLOGIC SECTION U-U'

JOB NO MV 9600

FIGURE 13-44

BEST DOCUMENT AVAILABLE


WEST-NORTHWEST
U
ELEVATION
MSL
FEET
METERS
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-500
-1000
-1500
-2000
GULF
NO.1 STEVENS
MINSEARCH
NO. B-6 RIDGWAY
EXPLORO NO. B-11
RIDGWAY
DOE MRIG-9 MASONITE
MINSEARCH
NO. 1 BACKSTROM
GENERALIZED GROUND SURFACE
MERRY NO.1
MASONITE
EAST-SOUTHEAST
U'
ELEVATION
MSL
MIOCENE UNDIFFERENTIATED
VICKSBURG GROUP
JACKSON GROUP
CLAIBORNE GROUP
RICHTON DOME
WILCOX GROUP
MIDWAY GROUP
SELMA GROUP
4000
0
4000
FEET
1000
0
1000
METERS
LEGEND
● TOP OF LOGGED INTERVAL
CAPROCK
SALT

VERTICAL EXAGGERATION 4X

SEE FIGURE 13-44 FOR CROSS-SECTION LOCATION

PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED DATE 12/4/81

T-1296-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
GEOLOGIC SECTION U-U'

JOB NO. MV9600

FIGURE 13-45

BEST DOCUMENT AVAILABLE

234 meters (767 ft). Known thicknesses of caprock vary from 6 meters (20 ft) near the margin of the dome to 65 meters (213 ft) near the center. The gravity model of the caprock (Figure 13-40) indicates that it is elliptically shaped and shares a north-northwesterly axial trend with the underlying salt. The crest of the caprock is approximately 61 meters (200 ft) thick at -76 meters (-250 ft) MSL. It slopes outward at varying degrees to a feather edge at -610 meters (-2,000 ft) MSL. The caprock surface is domed at the center where it is about 15 meters (50 ft) higher than the northwesterly trending ridge which surrounds the center (Figure 13-40).

Salt and caprock were cored in the Area Characterization Well DOE MRIG-9 Masonite. In this well, the caprock consists of anhydrite with gypsum-filled veins, except in the upper 7 meters (23 ft), where vuggy limestone is interbedded with calcite. Several brecciated and vuggy, gypsum-rich zones with minor quantities (less than 2 percent) of native sulfur and calcite occur in the lower part of the caprock.

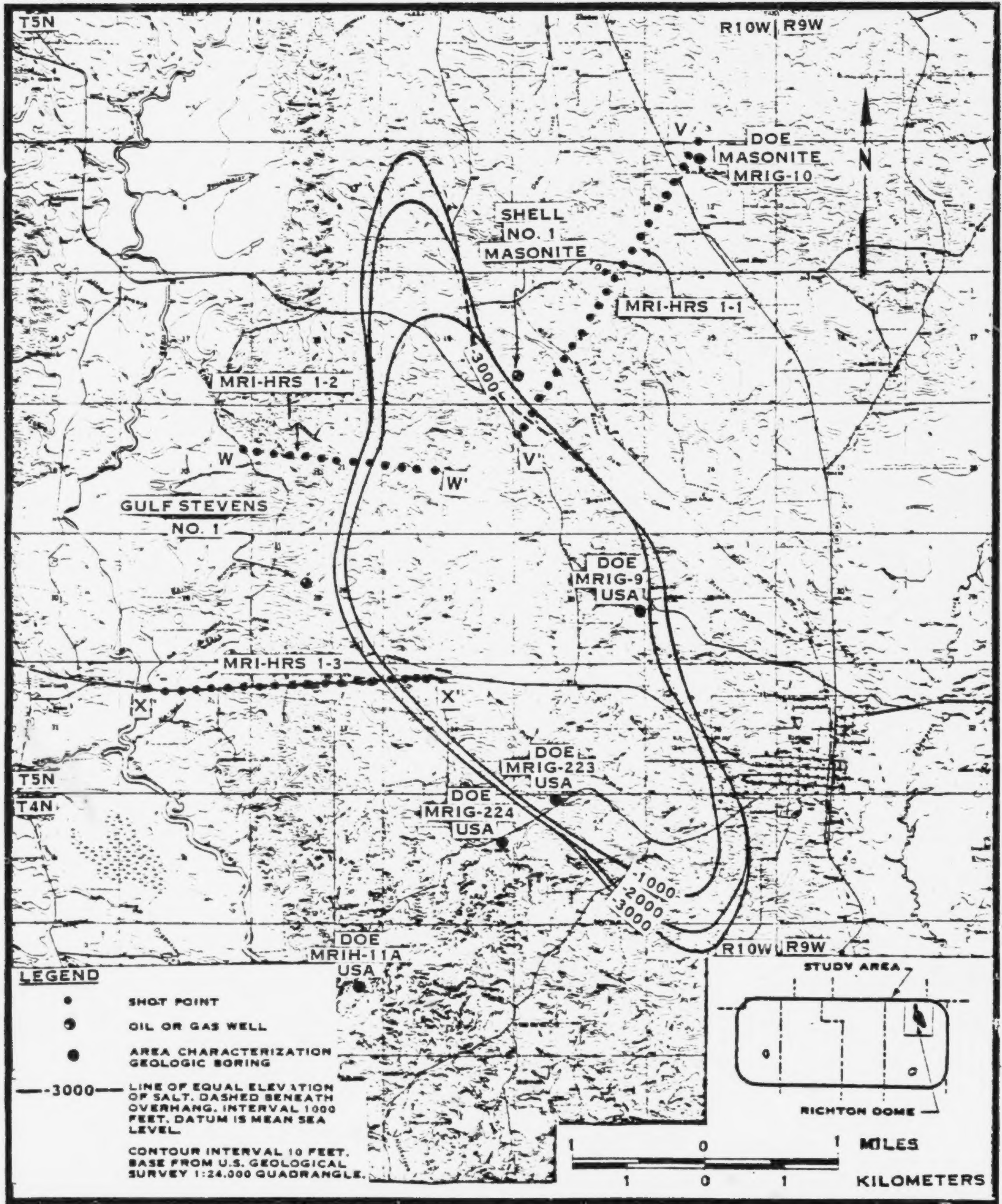
In the nine wells drilled into it, salt was encountered at depths between 220 and 259 meters (722 and 851 ft), which correspond to elevations of -155 and -181 meters (-508 to -593 ft) MSL. The depth to salt, averaging 229 meters (750 ft), is greater near the margin of the dome. In the DOE MRIG-9 Masonite core, the salt generally consists of fine to coarse-grain [less than 51 mm (2 in) across] equidimensional to prolate halite crystals, with an anhydrite-rich zone in the upper 2 meters (6 ft). Numerous halite megacrystal zones, which are usually bordered by an anhydrite band approximately 6 mm (0.25 in) thick, are present. Anhydrite also occurs as disseminated grains or as distinct inclusions in the salt. The anhydrite content of the entire core probably does not average over 10 percent. The DOE MRIG-9 Masonite well was terminated after coring 155 meters (508 ft) of salt.

Three Area Characterization high-resolution seismic reflection lines were used to help define the geometry of the dome flanks to -914 meters (-3,000 ft) MSL (Figures 13-46 through 13-49).

13.3.2 NEAR-DOME GEOLOGY: This section describes surface features and the stratigraphy and structure of the units in the Richton Dome area. A detailed discussion of stratigraphic units and relationships is contained in Section 12.2.2.

13.3.2.1 Surface Features: The Richton Dome area, situated in the Piney Woods Physiographic Subprovince, is generally typical of the Mississippi Study Area as a whole. The land surface is rolling to hilly (Figures 13-37 and 13-50), with moderate relief developed by mature dendritic dissection of the Hattiesburg and Citronelle Formations. Alluvial terraces are found in the valleys of the larger, higher-order streams. Land use in the near-dome area is generally limited to industrial pine forests and farming. Near-surface mineral resource development is discussed in Section 13.3.3.

AF 12338A


T5N
R10W
R9W
N
V
DOE MASONITE MRIG-10
SHELL NO. 1 MASONITE
MRI-HRS 1-1
-3000
MRI-HRS 1-2
W
W'
V'
GULF STEVENS NO. 1
DOE MRIG-9 USA
MRI-HRS 1-3
X
X'
DOE MRIG-223 USA
DOE MRIG-224 USA
T5N
T4N
-1000
-2000
-3000
R10W
R9W
DOE MRIH-11A USA
LEGEND
SHOT POINT
OIL OR GAS WELL
AREA CHARACTERIZATION GEOLOGIC BORING
-3000 LINE OF EQUAL ELEVATION OF SALT. DASHED BENEATH OVERHANG. INTERVAL 1000 FEET. DATUM IS MEAN SEA LEVEL.
CONTOUR INTERVAL 10 FEET. BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLE.
STUDY AREA
RICHTON DOME
1
0
1
MILES
1
0
1
KILOMETERS

PREPARED JDG DATE [illegible]
REVISED [illegible] DATE [illegible]
REVISED ______ DATE ___
APPROVED [illegible] DATE [illegible]
T-1413-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
LOCATION MAP - HIGH RESOLUTION SEISMIC SECTIONS V-V,' W-W', X-X'
JOB NO. MV9600 FIGURE 13-46

[redacted]
214 BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

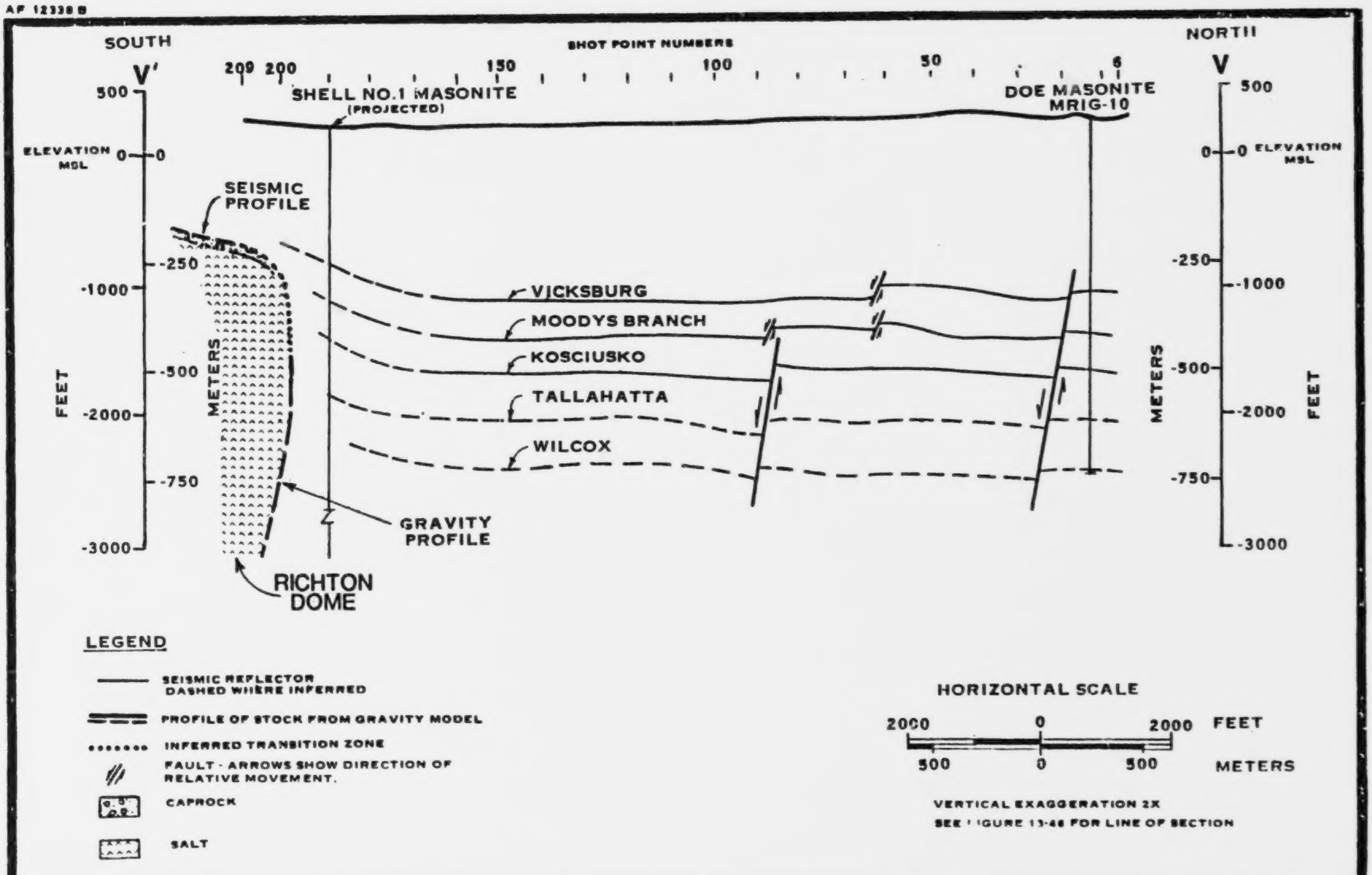

AF 12338 B
SOUTH
V'
SHOT POINT NUMBERS
209
200
150
100
50
6
NORTH
V
SHELL NO.1 MASONITE (PROJECTED)
DOE MASONITE MRIG-10
500
ELEVATION MSL
0
-250
-1000
-500
-2000
-750
-3000
FEET
METERS
SEISMIC PROFILE
VICKSBURG
MOODYS BRANCH
KOSCIUSKO
TALLAHATTA
WILCOX
GRAVITY PROFILE
RICHTON DOME
LEGEND
SEISMIC REFLECTOR DASHED WHERE INFERRED
PROFILE OF STOCK FROM GRAVITY MODEL
INFERRED TRANSITION ZONE
FAULT - ARROWS SHOW DIRECTION OF RELATIVE MOVEMENT.
CAPROCK
SALT
HORIZONTAL SCALE
2000 0 2000 FEET
500 0 500 METERS
VERTICAL EXAGGERATION 2X
SEE FIGURE 13-46 FOR LINE OF SECTION

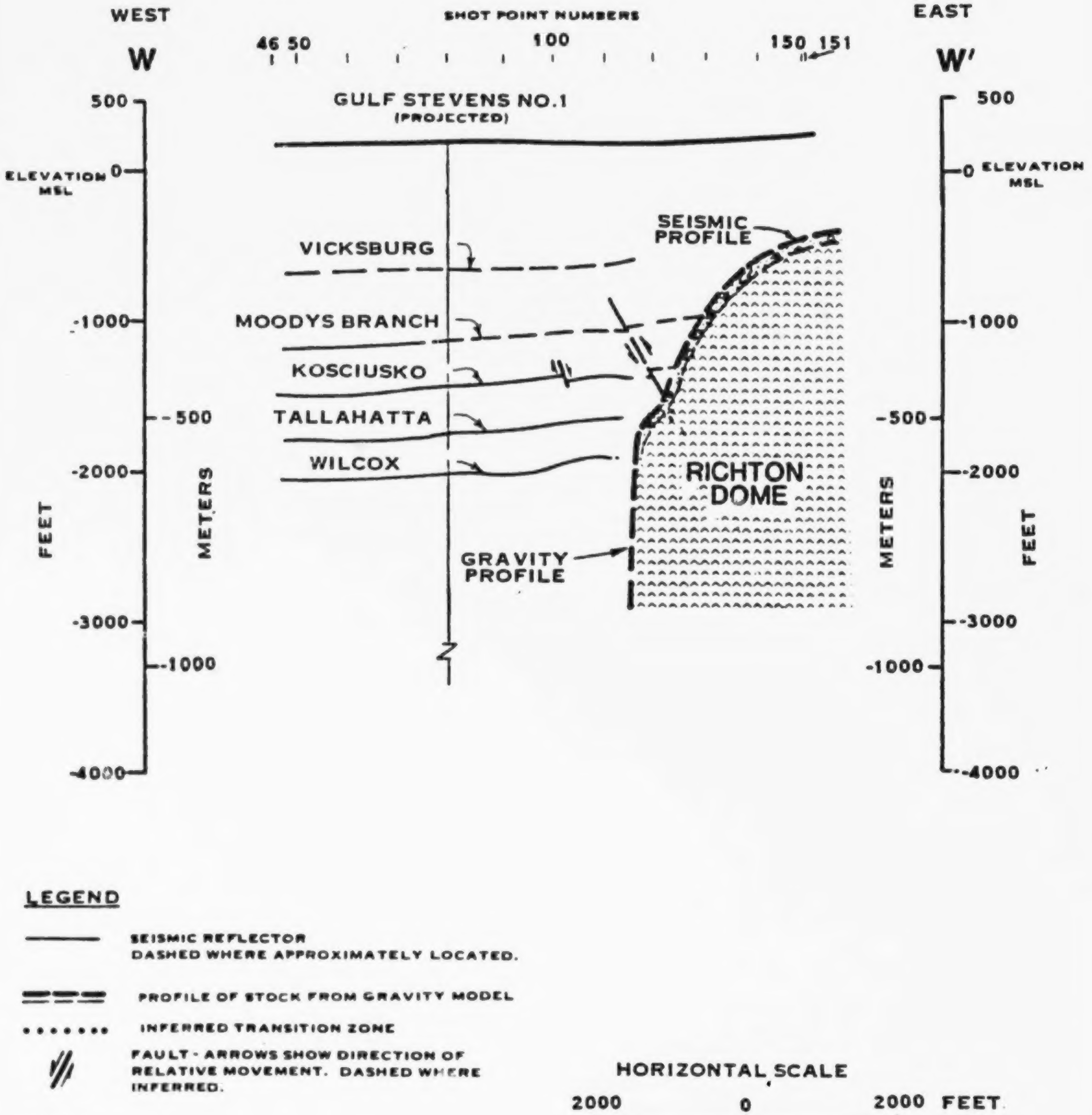
FIGURE 13-47

PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED OP DATE 12/4/81
T-1431-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
HIGH RESOLUTION
SEISMIC SECTION V-V'
JOB NO. MV9800 FIGURE 13-47

AF 12338A


WEST
SHOT POINT NUMBERS
EAST
W
46 50
100
150 151
W'
500
GULF STEVENS NO.1
(PROJECTED)
ELEVATION MSL
0
SEISMIC PROFILE
VICKSBURG
MOODYS BRANCH
KOSCIUSKO
TALLAHATTA
WILCOX
RICHTON DOME
GRAVITY PROFILE
-1000
-500
-2000
-3000
-1000
-4000
FEET
METERS
LEGEND
SEISMIC REFLECTOR DASHED WHERE APPROXIMATELY LOCATED.
PROFILE OF STOCK FROM GRAVITY MODEL
INFERRED TRANSITION ZONE
FAULT - ARROWS SHOW DIRECTION OF RELATIVE MOVEMENT. DASHED WHERE INFERRED.
SALT
CAPROCK
HORIZONTAL SCALE
2000
0
2000
FEET
500
0
500
METERS

VERTICAL EXAGGERATION 2X

SEE FIGURE 13-46 FOR LINE OF SECTION

PREPARED JDG DATE 8-15-80
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE ______
T-2118-0

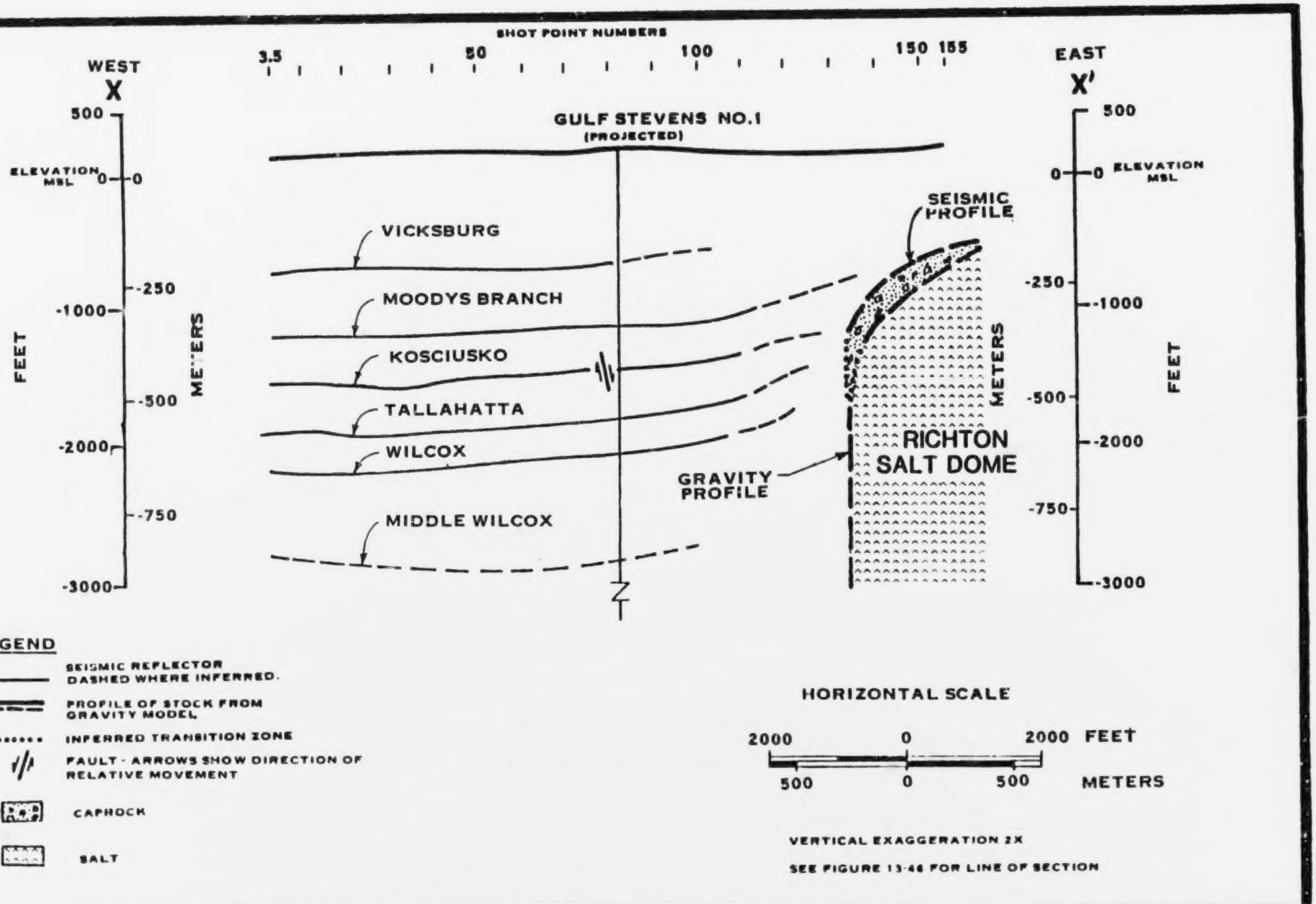
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
HIGH RESOLUTION SEISMIC SECTION W-W'
JOB NO. MV9600 FIGURE 13-48

216 BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

AF 12-36 B


SHOT POINT NUMBERS
3.5
50
100
150
155
WEST
X
EAST
X'
500
ELEVATION MSL
0
0
-250
-1000
-500
-2000
-750
-3000
FEET
METERS
GULF STEVENS NO.1
(PROJECTED)
VICKSBURG
MOODYS BRANCH
KOSCIUSKO
TALLAHATTA
WILCOX
MIDDLE WILCOX
SEISMIC PROFILE
GRAVITY PROFILE
RICHTON SALT DOME
LEGEND
SEISMIC REFLECTOR DASHED WHERE INFERRED.
PROFILE OF STOCK FROM GRAVITY MODEL
INFERRED TRANSITION ZONE
FAULT - ARROWS SHOW DIRECTION OF RELATIVE MOVEMENT
CAPROCK
SALT
HORIZONTAL SCALE
2000
0
2000
FEET
500
0
500
METERS
VERTICAL EXAGGERATION 2X
SEE FIGURE 13-46 FOR LINE OF SECTION

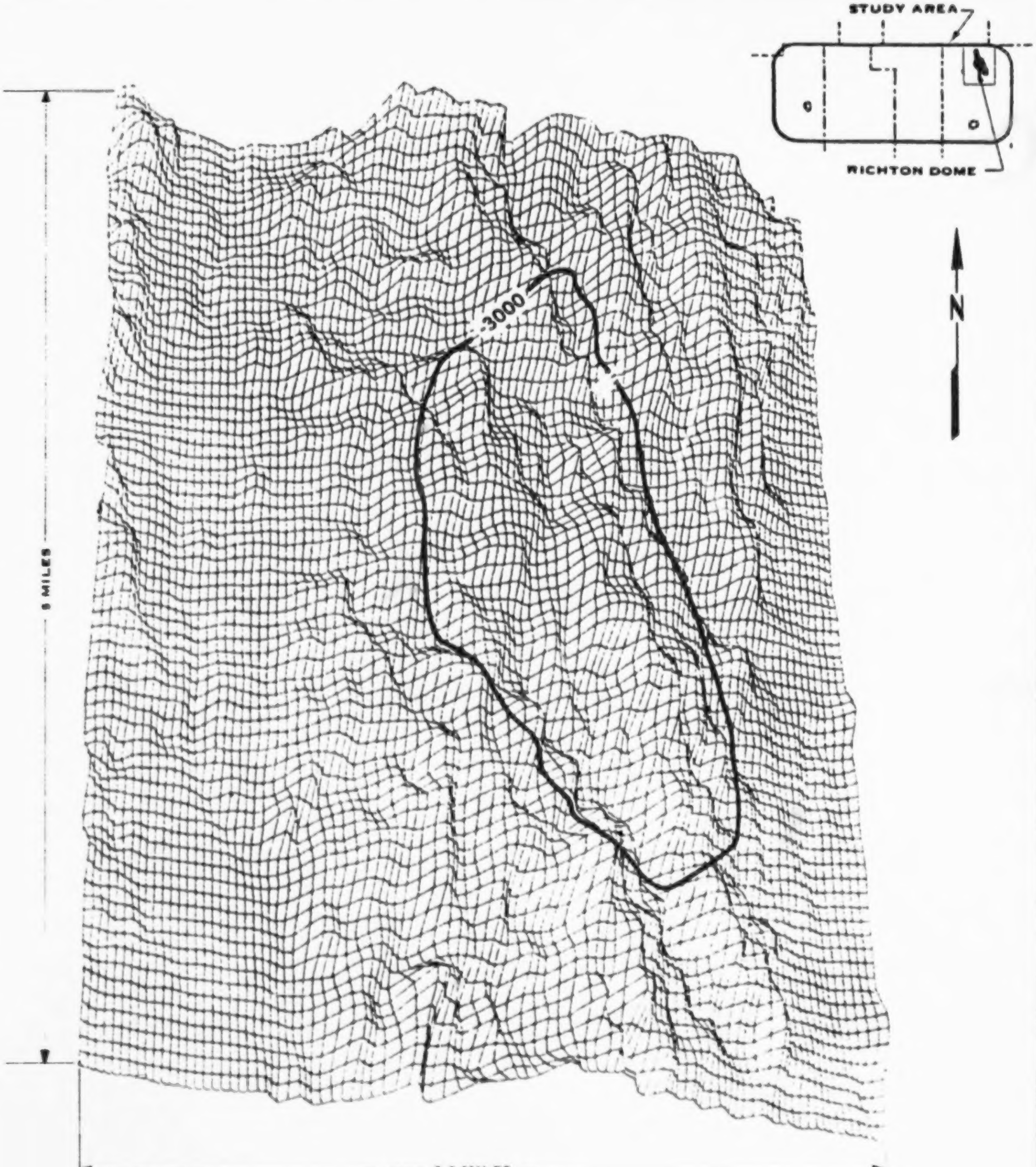
PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED DEP DATE 12/4/81
T-1433-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
HIGH RESOLUTION SEISMIC SECTION X-X'
JOB NO. MV9600
FIGURE 13-49

FIGURE 13-49

AF 12338A



LEGEND

——— -3000 ——— LINE OF EQUAL ELEVATION OF SALT. IN FEET. DATUM IS MEAN SEA LEVEL.

SALT CONTOUR AFTER KARGES. (1978)

PREPARED J.D.G. DATE 5-30-80 REVISED [illegible] DATE [illegible] REVISED ______ DATE ____ APPROVED [illegible] DATE [illegible] T-1297-1	NATIONAL WASTE TERMINAL STORAGE PROGRAM GEOLOGIC EVALUATION GULF COAST SALT DOMES LAW ENGINEERING TESTING COMPANY MARIETTA GEORGIA	MISSISSIPPI STUDY AREA RICHTON DOME THREE-DIMENSIONAL TOPOGRAPHIC PROJECTION JOB NO. MV9500 FIGURE 13-50

BEST DOCUMENT AVAILABLE

The 1970 population of Perry County was 9,065, or about 14 people per square mile (U.S. Bureau of the Census). The town of Richton, 0.8 km (0.5 mi) southeast of the supradomal area, has a 1976 population of 1,185 people. Richton is dominantly residential with some commercial and light industrial development. Land use over the supradomal area is approximately 80 percent industrial forest; the remainder is used for farming and pasturing. Land in the near-dome area is privately held, principally by the Masonite Corporation, except for Section 16 in each township, which is owned by Perry County, and a small amount of acreage owned by the town of Richton.

Surface elevations in the near-dome area range from a low of 27 meters (90 ft) above sea level on the banks of Bogue Homo Creek, near the southern boundary of the near-dome area, to a high of 96 meters (315 ft) approximately 3 km (2 mi) north-northeast of the supradomal area (Figure 13-37). Elevations over the supradomal area are between 49 and 88 meters (160 and 290 ft) MSL and are typical of the nondissected areas in the supradomal area and the study area as a whole. Ruggedness of the topography in the near-dome area is similar to that of adjacent areas having similar lithologies, except for an intricately dissected area immediately southwest of the dome crest. Rugged topography, both within and surrounding the supradomal area, appears to be lithologically controlled, and belts of similar rough terrain trend northwesterly (Figure 13-50). In general, topographic development in the near-dome area does not appear to reflect any recent acceleration of erosion, suggesting that the domal uplift has ceased.

An anomalous topographic feature does occur about 91 meters (300 ft) to the east of the supradomal area as a closed depression in the southwest quarter of Section 25, T5N, R10W (Figure 13-37). The Citronelle Formation is exposed in this area on a rather flat topographic high. The nature and cause of this feature is unknown.

Drainage is dominated by Bogue Homo and Thompson Creeks (Figures 12-1 and 13-37), major tributaries of the Leaf River, which flow in a southerly direction along the western and eastern margins of the near-dome area. Beaver Dam Creek, which flows southward to within 0.5 km (0.3 mi) of the dome crest, abruptly veers in a southeasterly direction to its confluence with Thompson Creek (Figure 13-51), indicating possible structural influence in the near-dome area.

Field geologic mapping supports the observation that the drainage courses in the near-dome area are dominantly controlled by variations in lithology. Generally open dendritic drainage is characteristic of the outcrop of the sands of the Hattiesburg and of the Citronelle sands and gravels. In contrast, the intricate dendritic drainage is characteristic of the silts and clays of both the Hattiesburg and Citronelle.

Drainage courses over the supradomal area are radial in the northern part, while centripetal drainage patterns are predominant in the south. Pine Branch Creek, which drains the southern portion of the supradomal area, flows southeasterly to Thompson Creek. The Pine Branch Creek network, in growing headward, is integrating the drainage in the southern portion of the supradomal area. Its valley is more deeply incised than the valleys of neighboring streams of equivalent order, probably because of the lithologic control of drainage in this area. Pine Branch Creek is parallel to the caprock ridge discussed previously in Section 13.3.1. Drainage density, when expressed by contours of link* frequency and drainage ratio (Figures 13-52 and 13-53), suggests lithologic impact on drainage courses by exposed sediments, which is confirmed by the correspondence between drainage density and outcrop pattern discussed previously. With the exception of the course divergence of Beaver Dam Creek, no pronounced drainage anomalies indicative of structural features are apparent in the near-dome area.

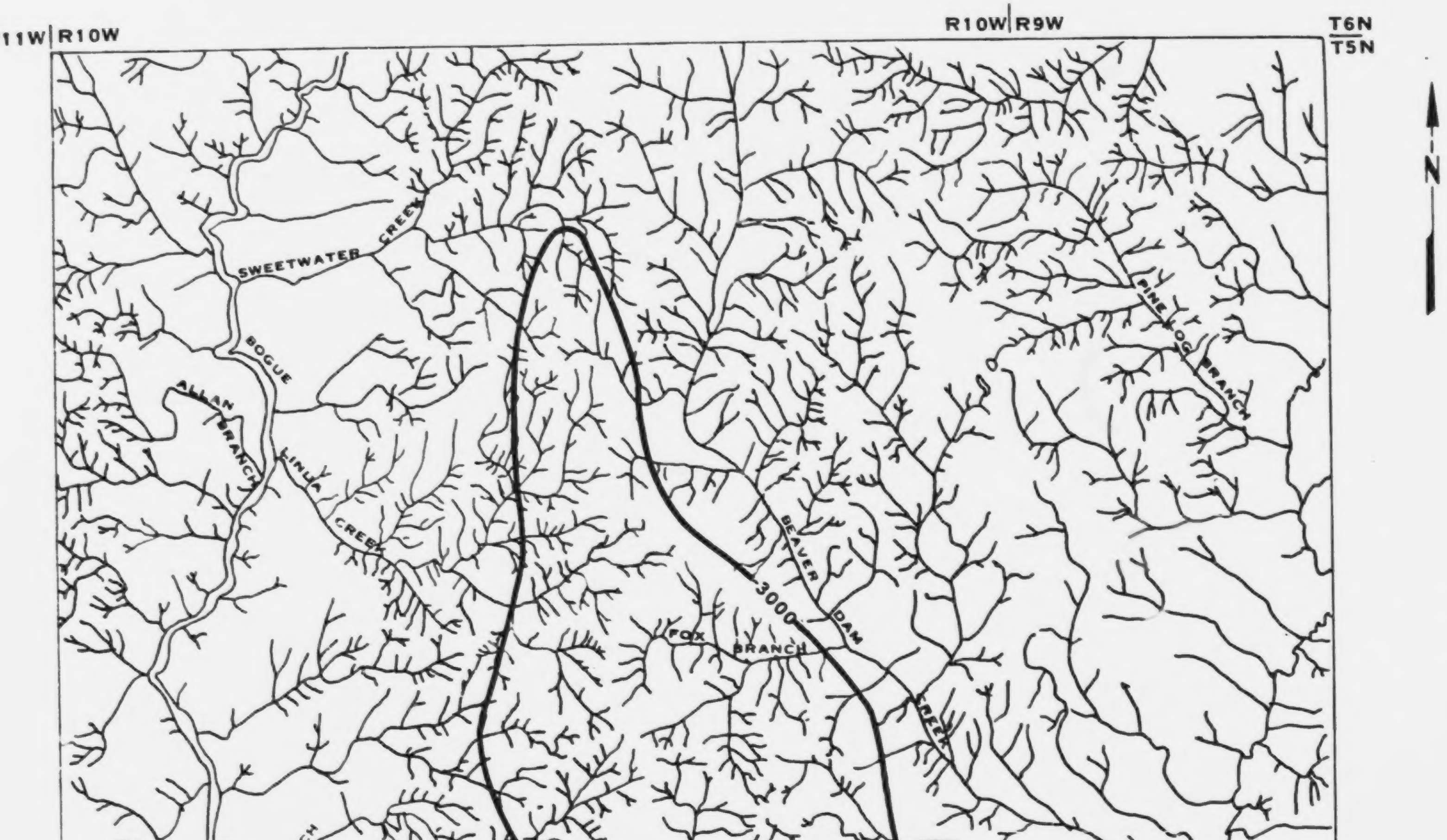
Surface geologic mapping and shallow borings, drilled for this study to depths of 168 meters (550 ft), demonstrate that four stratigraphic units are exposed in the dome area. From oldest to youngest they are the Hattiesburg Formation, Citronelle Formation, terrace deposits of presumed Quaternary age, and Recent alluvium (Figure 13-54). The Hattiesburg Formation consists of massive greenish-gray silty clays and fine sandy, silty clays which oxidize to a grayish-tan, nodular silty clay, with lenses of gray, silty, fine sand. The Hattiesburg beds are exposed over approximately one-sixth of the near-dome area, principally on the interstream divides at the higher topographic levels (Figure 13-54). The Hattiesburg is also found in the

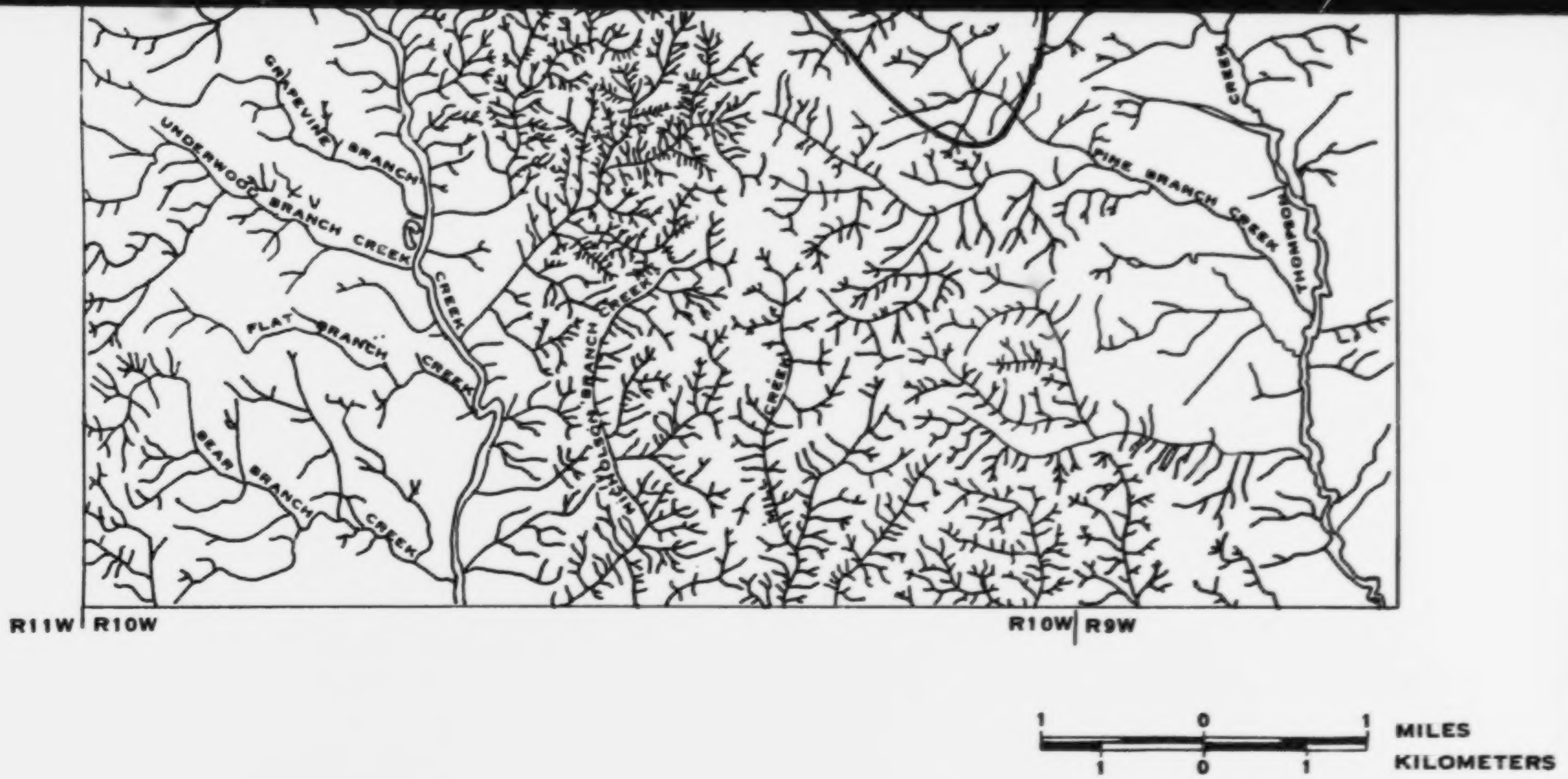
---

*Segment of trunk stream between tributary branches.

222

BEST DOCUMENT AVAILABLE

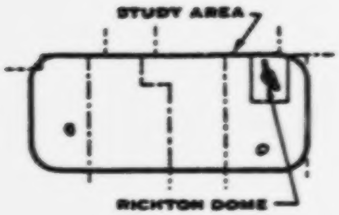

R11W | R10W
R10W | R9W
T6N
T5N
N
SWEETWATER CREEK
BOGUE
ALLAN BRANCH
LINUA CREEK
BEAVER DAM CREEK
3000
FOX BRANCH
PINE LOG BRANCH
PINE BRANCH
HOMO
BRANCH
HARPER
GRAPEV
CREEK
T5N
T4N
T5N
T4N


GRAPEVINE BRANCH
UNDERWOOD BRANCH CREEK
CREEK
FLAT BRANCH CREEK
BEAR BRANCH CREEK
NICHOLSON BRANCH CREEK
MILL CREEK
PINE BRANCH CREEK
THOMPSON
CREEK
R11W R10W
R10W R9W
1 0 1 MILES
1 0 1 KILOMETERS

LEGEND

—-3000— LINE OF EQUAL ELEVATION OF SALT. IN FEET. DATUM IS MEAN SEA LEVEL.

STREAM


STUDY AREA
RICHTON DOME

BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLES

PREPARED J.D.G. DATE 5-30-80
REVISED [illegible] DATE [illegible]
REVISED ______ DATE ______
APPROVED [illegible] DATE [illegible]

T-1298-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

RICHTON DOME

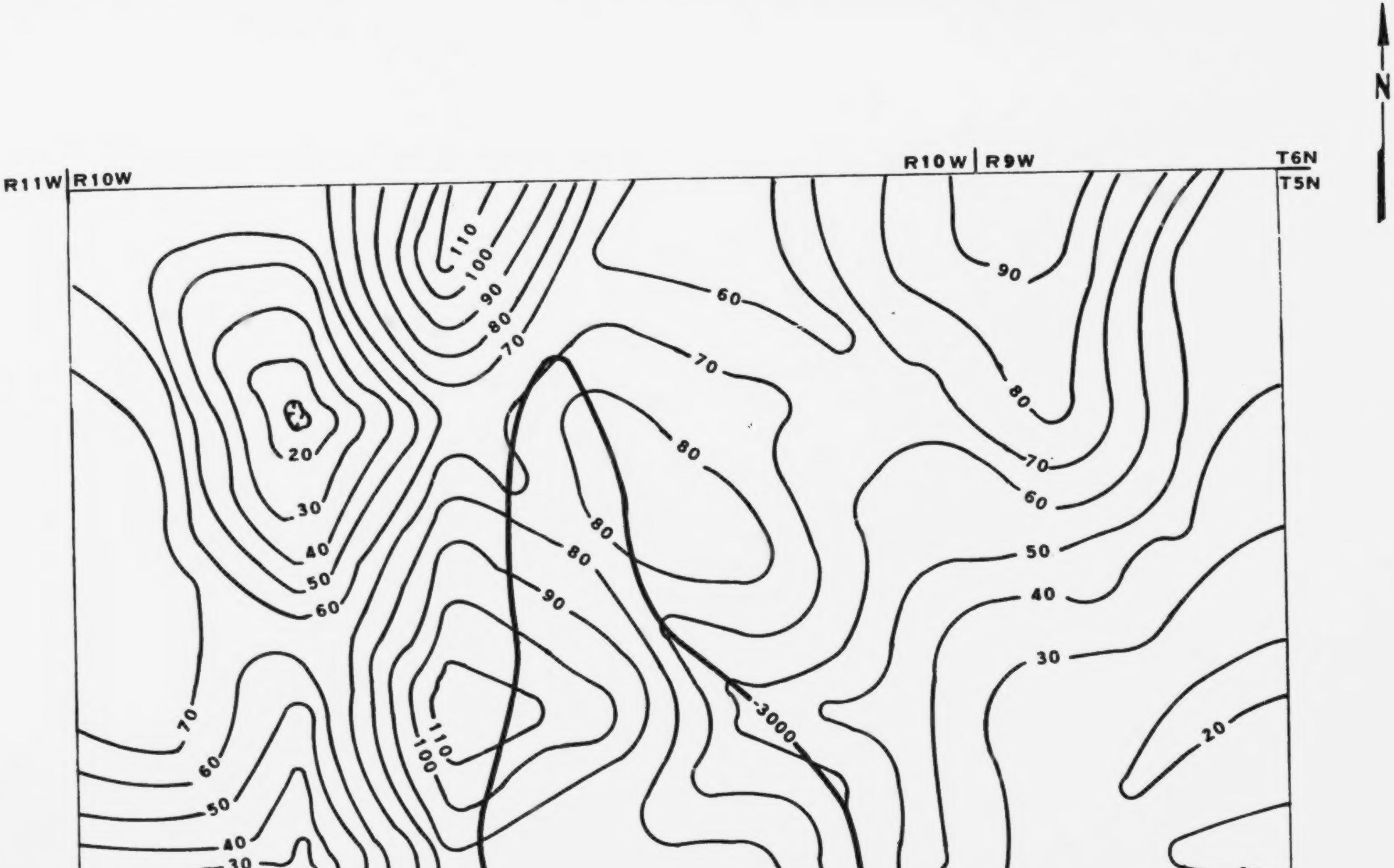
DRAINAGE NETWORK

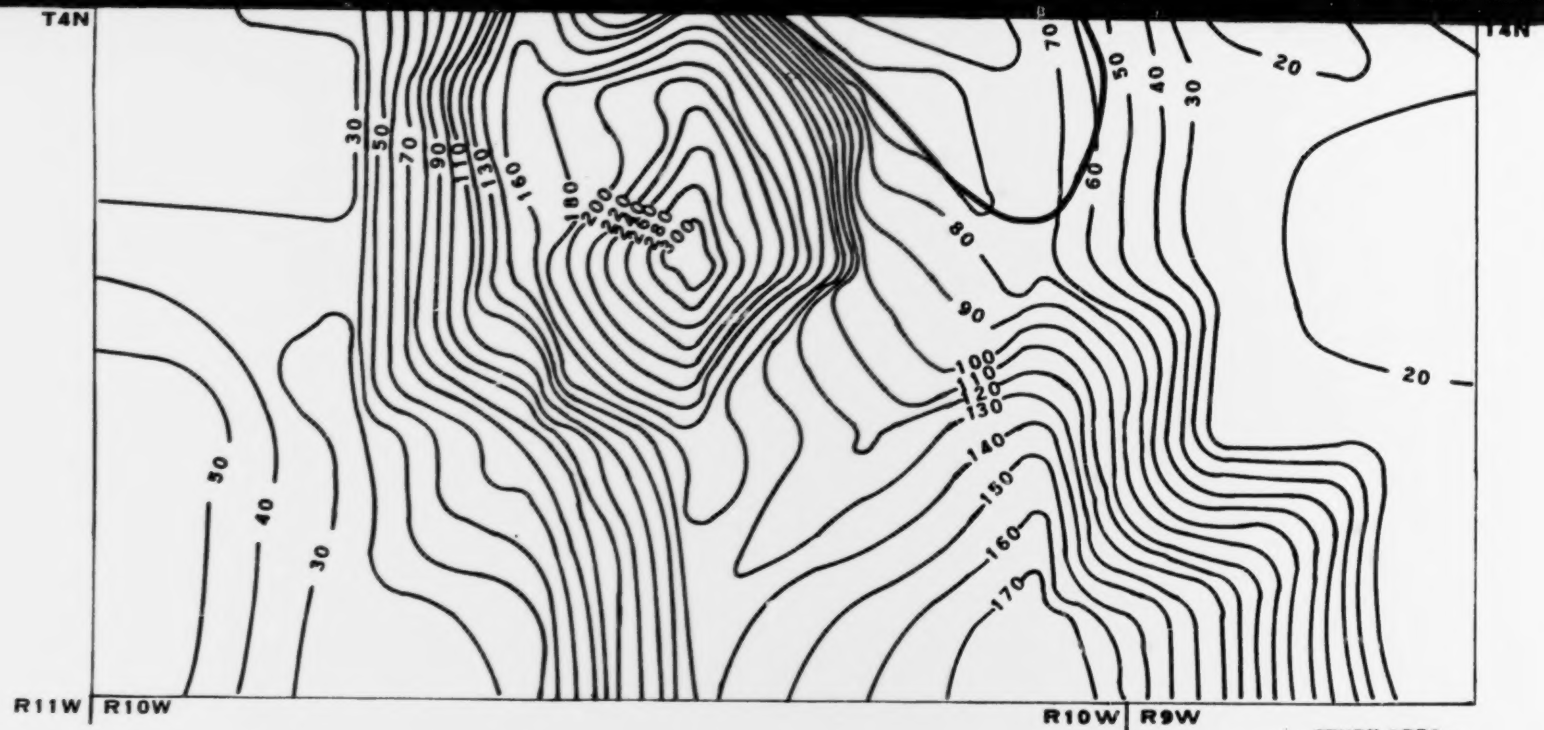
JOB NO. MV 9600

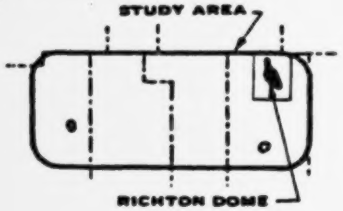
FIGURE 13-51

FIGURE 13-51

BEST DOCUMENT AVAILABLE


N
R11W
R10W
R10W
R9W
T6N
T5N
T5N
T4N
T5N
T4N
110
100
90
80
70
60
70
80
90
80
70
60
50
40
30
20
30
30
20
20
30
40
50
60
80
80
90
110
100
70
60
50
40
30
-3000
70
50
40
30
20


T4N
T4N
30
50
70
90
110
130
160
180
200
300
80
90
100
110
120
130
140
150
160
170
70
50
40
30
60
20
20
50
40
30
R11W
R10W
R10W
R9W


STUDY AREA
RICHTON DOME

LEGEND

—— -3000 —— LINE OF EQUAL ELEVATION OF SALT. IN FEET. DATUM IS MEAN SEA LEVEL.

—— 30 —— LINE OF EQUAL NUMBER OF DRAINAGE LINKS PER SQUARE MILE. INTERVAL VARIABLE.

1
0
1
MILES
1
0
1
KILOMETERS

223
A

FIGURE 13-52

PREPARED J.D.G. DATE 5-30-80
REVISED DJ DATE [illegible]
REVISED DATE
APPROVED [illegible] DATE [illegible]

T-1299-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

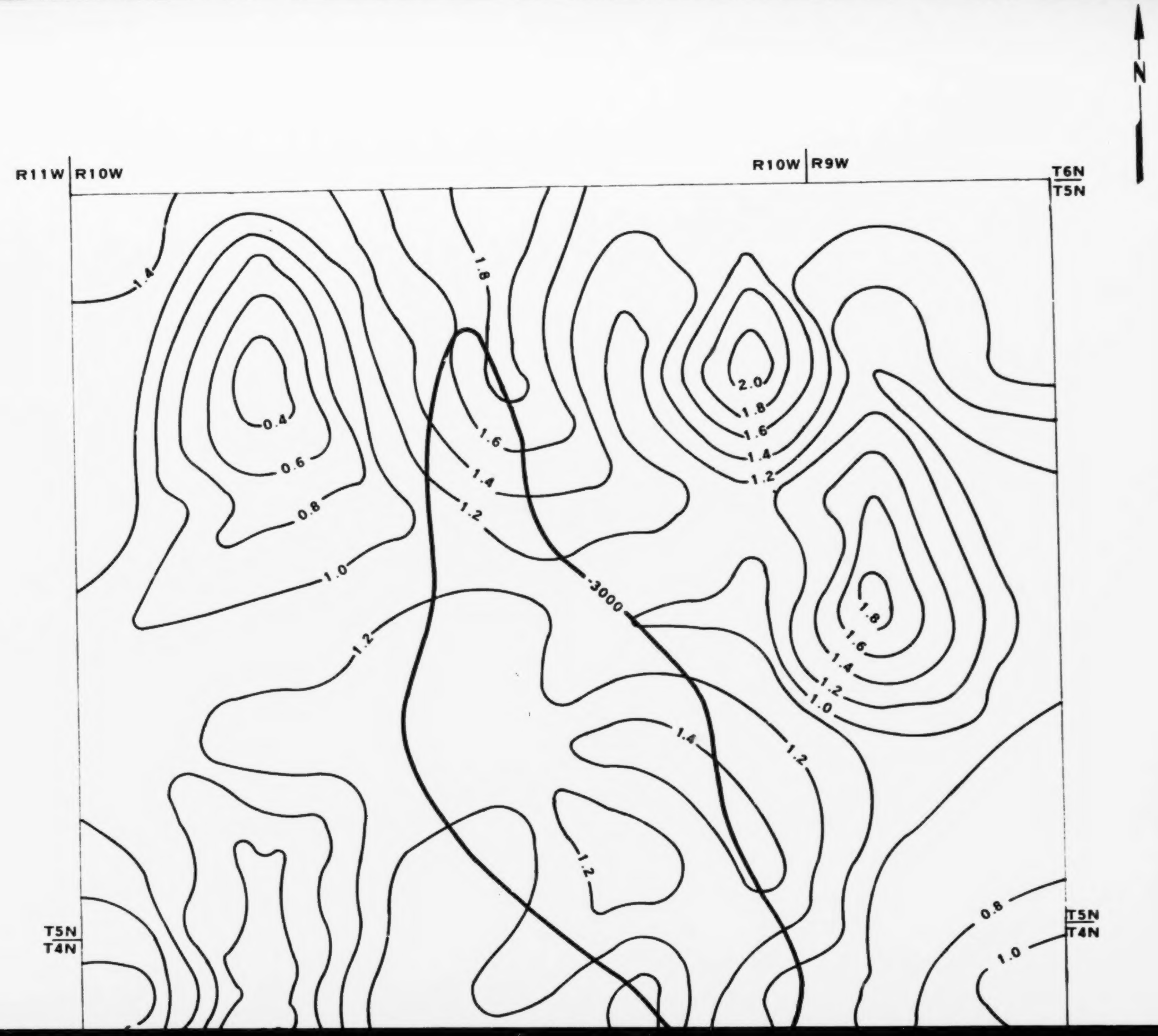
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

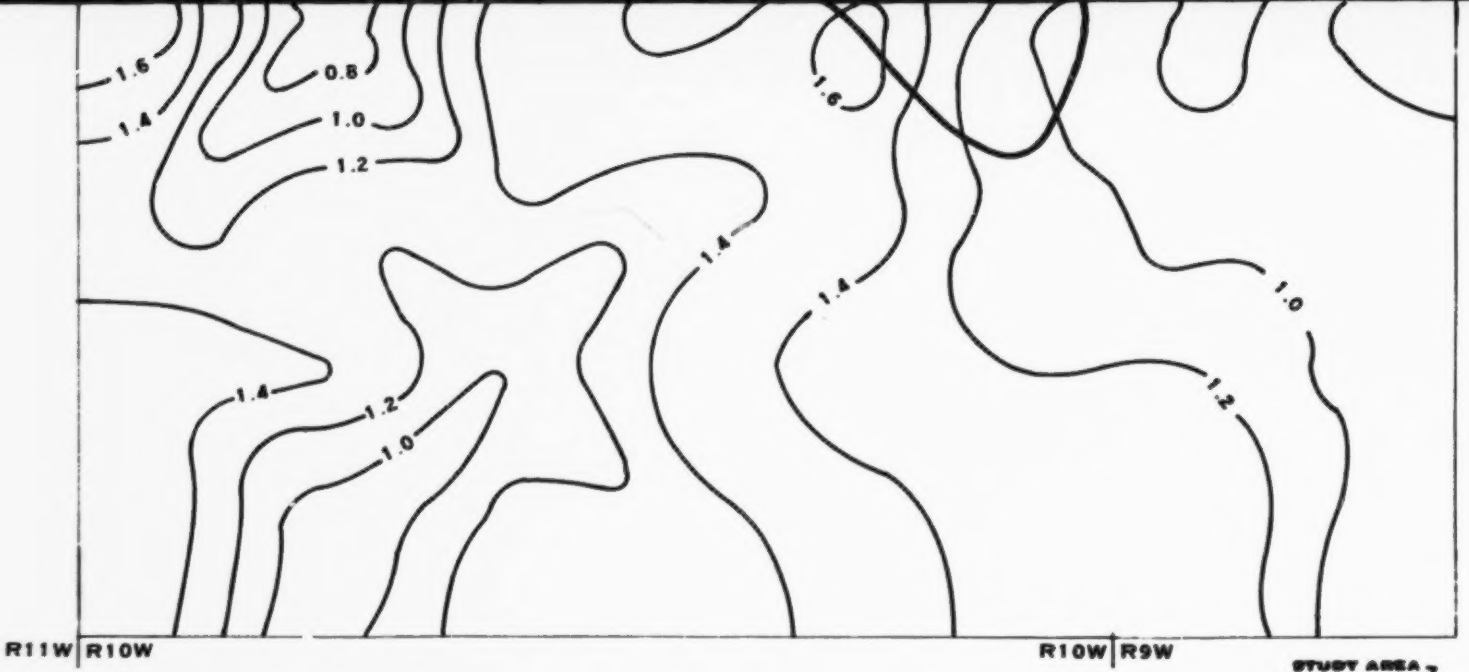
MISSISSIPPI STUDY AREA
RICHTON DOME
ISOLINES OF EXTERIOR / INTERIOR
DRAINAGE LINK FREQUENCY

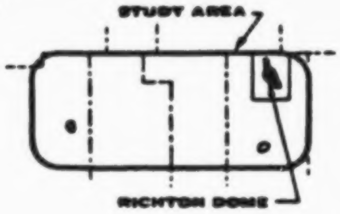
JOB NO. MV 9600
FIGURE 13-52

224

BEST DOCUMENT AVAILABLE


N
R11W
R10W
R10W
R9W
T6N
T5N
T5N
T4N
T5N
T4N
1.4
1.8
0.4
0.6
0.8
1.0
1.6
1.4
1.2
2.0
1.8
1.6
1.4
1.2
-3000
1.2
1.8
1.6
1.4
1.2
1.0
1.4
1.2
1.2
0.8
1.0


1.6
0.8
1.4
1.0
1.2
1.6
1.4
1.4
1.0
1.4
1.2
1.0
1.2
R11W
R10W
R10W
R9W


STUDY AREA
RICHTON DOME

224A

LEGEND

— -3000 — LINE OF EQUAL ELEVATION OF SALT. IN FEET. DATUM IS MEAN SEA LEVEL.

— 1.4 — LINE OF EQUAL RATIO OF EXTERIOR/INTERIOR DRAINAGE LINKS PER SQUARE MILE. INTERVAL 0.2 UNITS.

1
0
1
MILES
1
0
1
KILOMETERS

FIGURE 13-53

PREPARED J.D.G.	DATE 5-30-80
REVISED [illegible]	DATE [illegible]
REVISED	DATE
APPROVED [illegible]	DATE 5/[illegible]/80

T-1300-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

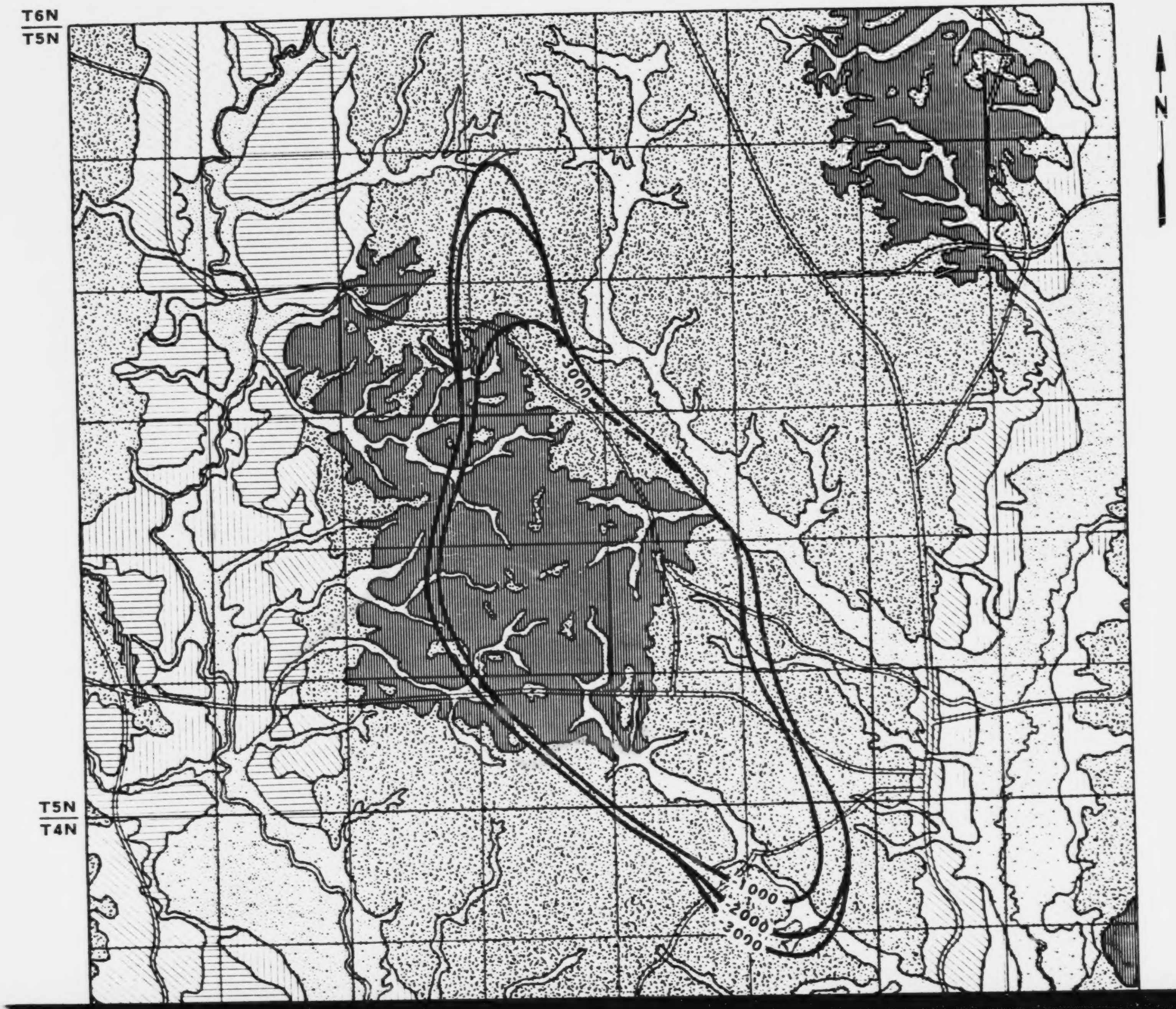
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

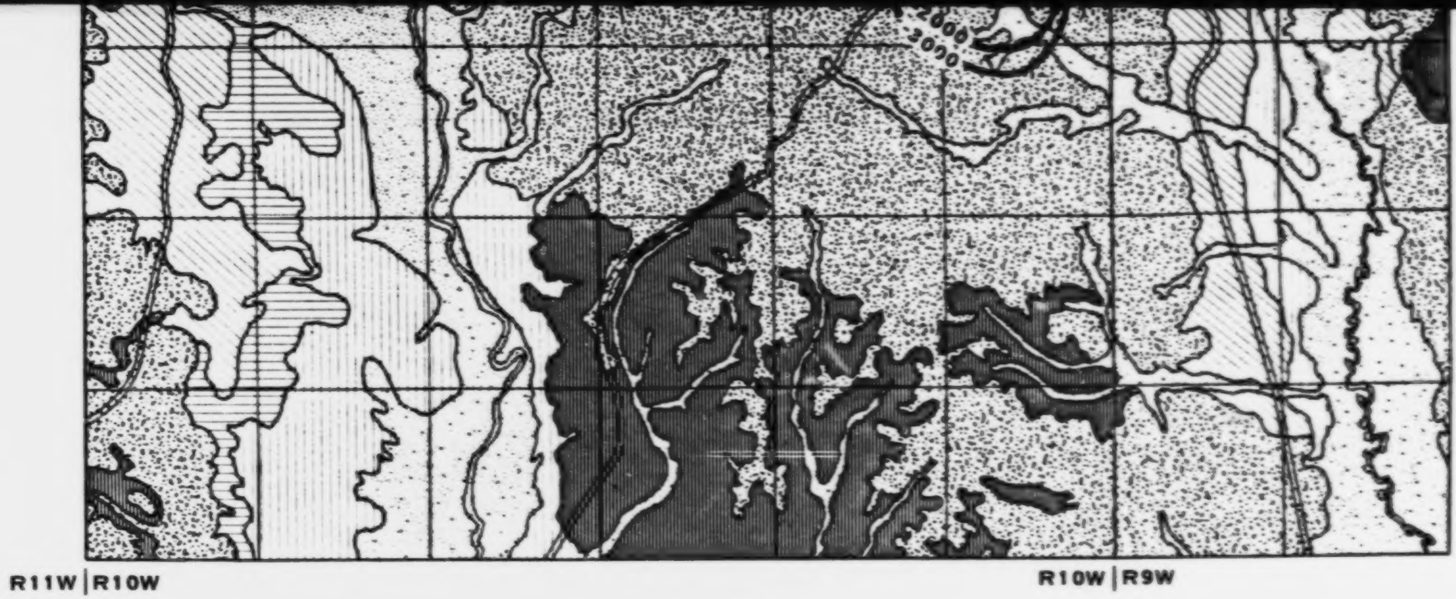
MISSISSIPPI STUDY AREA
RICHTON DOME
ISOLINES OF DRAINAGE RATIO

JOB NO. MV9600

FIGURE 13-53

BEST DOCUMENT AVAILABLE


T6N
T5N
N
3000
T5N
T4N
1000
2000
3000
3000


2000
3000
R11W | R10W
R10W | R9W

LEGEND

QUATERNARY — PLEISTOCENE AND RECENT

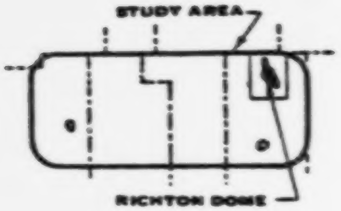
- ⬚ ALLUVIUM
- ▥ LOWER TERRACE DEPOSITS
- ▤ INTERMEDIATE TERRACE DEPOSITS
- ▨ UPPER TERRACE DEPOSITS

TERTIARY — MIOCENE PLIOCENE

- ⬚ CITRONELLE FORMATION
- ■ HATTIESBURG FORMATION

—-1000— LINE OF EQUAL ELEVATION OF SALT. DASHED BENEATH SALT OVERHANG. DATUM IS MEAN SEA LEVEL.

═ ROAD


STUDY AREA
RICHTON DOME

1
0
1
MILES
1
0
1
KILOMETERS

BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLES.

225A

PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED DATE 12/4/81

T-1301-0

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
GEOLOGIC MAP

JOB NO. MV9600

FIGURE 13-54

drainage courses where terrace and Recent alluvial deposits are absent. The Hattiesburg is exposed over about 50 percent of the northern and west-central portions of the supradomal area, where the Citronelle Formation apparently has been completely eroded.

The Citronelle covers about one-half of the near-dome area. It is exposed on the higher interstream hills as is the Hattiesburg. The Citronelle Formation covers about 30 percent of the extreme northern as well as the southern and eastern portions of the supradomal area. It consists of reddish-brown to yellowish-brown, gravelly, coarse to fine-grain sand with lenses and interbedded silt, silty clay, and clay. The gravelly sands appear to occur primarily in the basal portion, although pods and lenses of gravel occur throughout the section.

Terrace deposits, composed of tan to buff quartzose silt at the surface, and at depth lithologically similar to the Citronelle Formation, are found at several topographic levels adjacent to the dome in Bogue Homo and Thompson Creeks (Figure 13-54). These terrace surfaces are nearly horizontal and occur at similar elevations (Paulson and others, 1980), a situation which may mean the terraces resulted from eustatic (sea level) changes or by regional uplift during Pleistocene time. The correspondence of elevations of the various terrace levels, both over the dome and adjacent to it, suggests that the terraces were not formed as a result of domal movement, and that they have not been vertically displaced or warped by local domal movement in Recent geologic time.

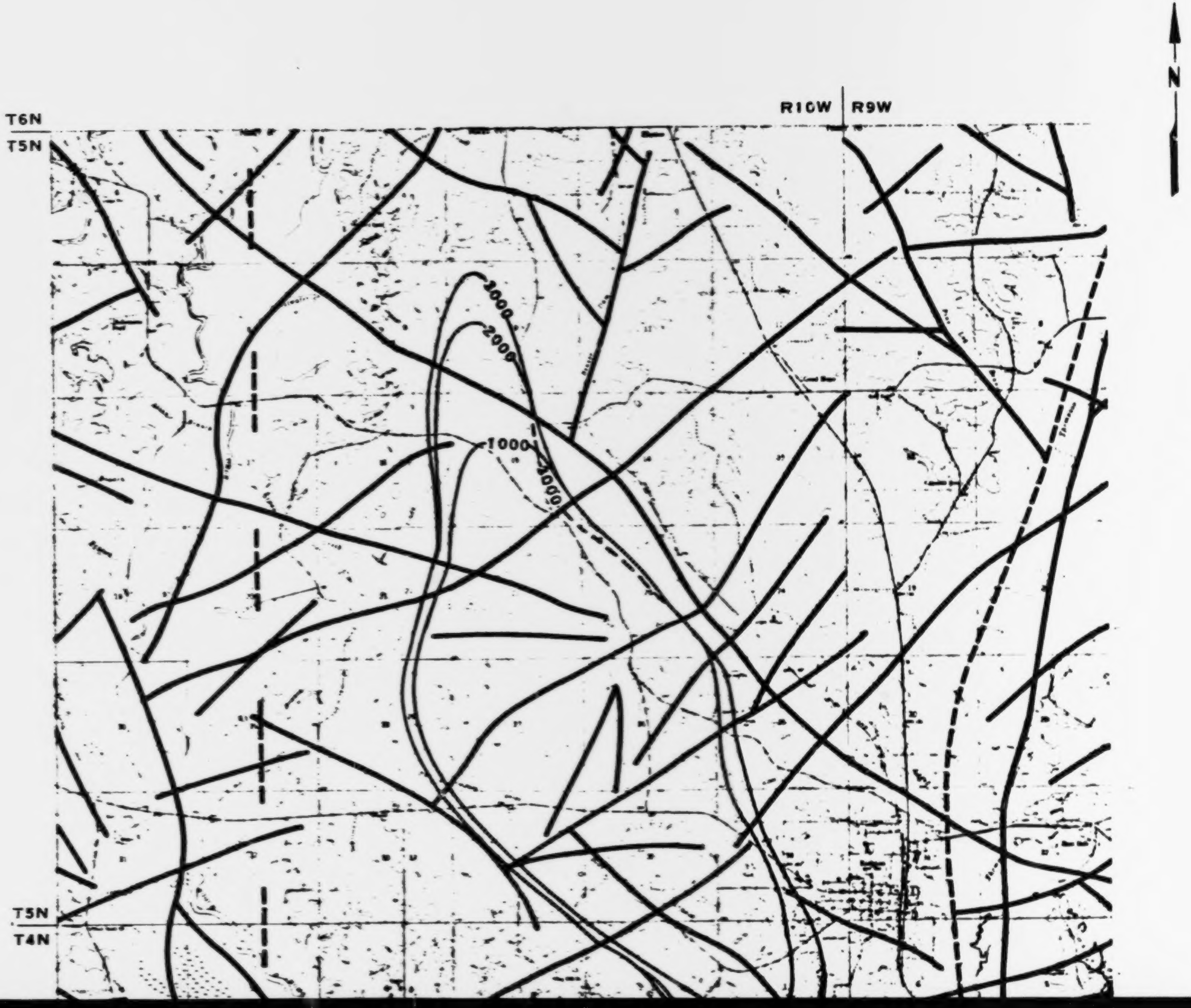
Recent alluvial deposits fill the modern valleys and underlie the flood plains of Bogue Homo and Thompson Creeks, and the lower portion of Beaver Dam Creek. These deposits generally consist of tan, grayish tan, reddish-brown, and brown silty, fine-grain sands, silts, clays, and coarse to fine grain, sandy, quartzose and cherty gravel, with abundant organic material. There is no clear evidence that domal growth has exerted influence or control on the geomorphic features in the area in the recent geologic past. Of interest, however, is the rather abrupt change in the width of the flood plain in the lower course of Bogue Homo Creek. North of this point, the creek is apparently incising bedrock, yet to the south it is downcutting the flood plain. This change occurs 3 km (2 mi) west of the dome, but it cannot be demonstrated at this time that domal movement is responsible for this situation. This may be related to a Citronelle age channel as discussed in Section 13.3.2.3.

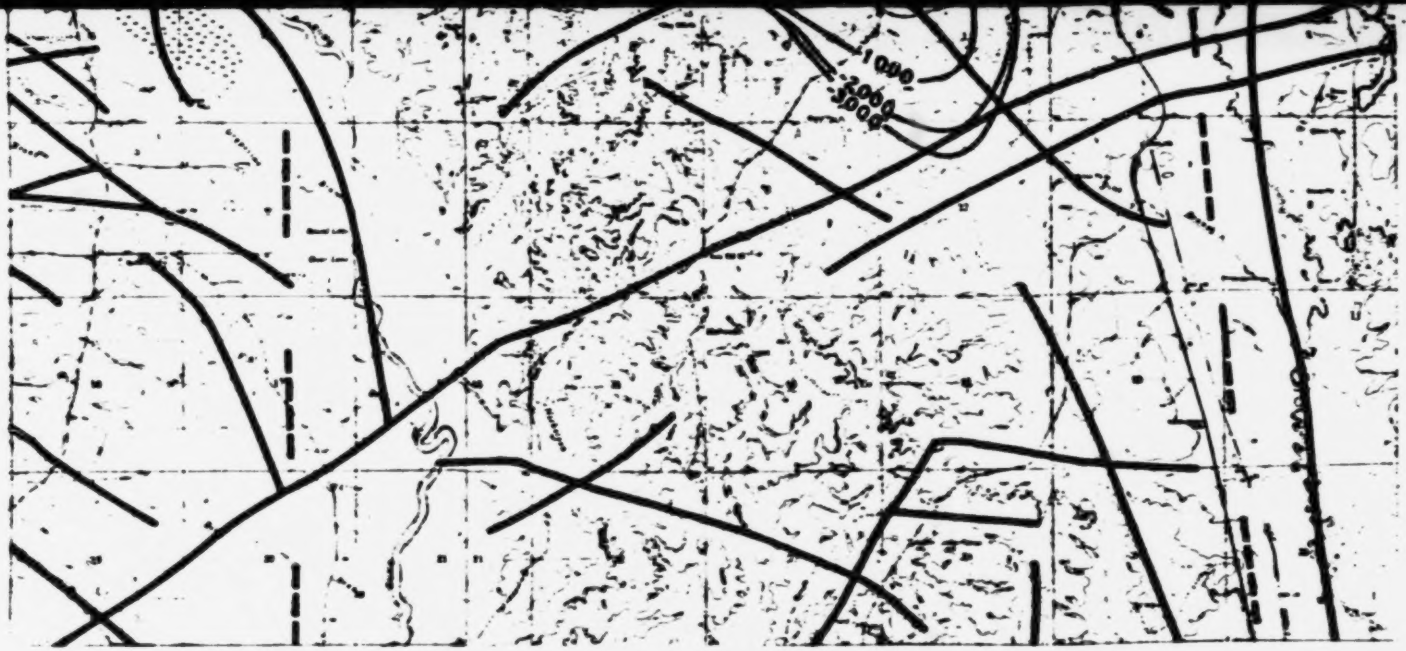
The supradomal area includes two Landsat lineaments which trend in a northerly direction coincident with the valleys of Bogue Homo and Thompson Creeks (Figure 13-55). As discussed previously in Chapter 12, these long lineaments typically coincide with the major trunk channels in the study area drainage system.

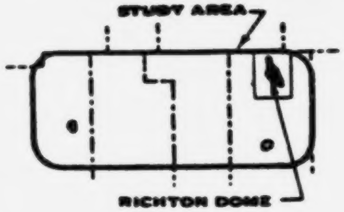
Numerous lineaments have been observed on color infrared photographs of the dome area. These lineaments exhibit the strongly bimodal orientation typical of the study area, trending northwest-southeast and northeast-southwest. Most long color-infrared lineaments correspond to the positions of topographic lows and drainage features in the dome area. Lineament density over the dome is not noticeably higher than that of adjacent areas, suggesting a lack of domal influence on lineament density (Figure 12-8).

228

BEST DOCUMENT AVAILABLE


N
T6N
T5N
R10W
R9W
3000
2000
1000
2000
T5N
T4N





LEGEND

—— -1000 — — — LINE OF EQUAL ELEVATION OF SALT. DASHED BENEATH SALT OVERHANG INTERVAL 1000 FEET. DATUM IS MEAN SEA LEVEL.

▬▬▬▬ HIGH ALTITUDE COLOR INFRARED LINEAMENTS

▬ ▬ ▬ ▬ ▬ ▬ ▬ DEFINITE LANDSAT LINEAMENTS

▬ ▬ ▬   ▬ ▬ ▬ INDEFINITE LANDSAT LINEAMENTS

1
0
1
MILES
1
0
1
KILOMETERS

CONTOUR INTERVAL 10 FEET.

BASE FROM U.S. GEOLOGICAL SURVEY 1:24,000 QUADRANGLE.

2.28A

FIGURE 13-55

PREPARED	J.D.G.	DATE	5-30-80
REVISED	[illegible]	DATE	[illegible]
REVISED		DATE	
APPROVED	[illegible]	DATE	[illegible]

T-1302-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
LINEAMENT MAP

JOB NO. MV9600

FIGURE 13-55

BEST DOCUMENT AVAILABLE

A prominent set of northeast-southwest-trending lineaments, each over 3 km (2 mi) long, extends across the dome and into areas immediately adjacent to the dome (Figure 13-55). The reason for this parallelism has not been determined. One lineament extending across the center of the dome is intersected by five shorter lineaments at acute angles, suggesting fracture patterns.

13.3.2.2 Stratigraphy: The stratigraphic section studied in the Richton Dome area includes all units younger than the Selma Group. Stratigraphic and structural relationships of the formations are shown on the Stratigraphic Chart (Table 13-3) and the geologic sections (Figures 13-43 and 13-45).

Lithologic descriptions and stratigraphic correlations to depths of 1,841 meters (6,040 ft) are based on petrologic and paleontologic analyses of drill cuttings and sidewall cores, and interpretations of geophysical logs obtained from borings drilled during Area Characterization (see the Mississippi Study Area Appendix.) Geophysical logs and cutting sample descriptions obtained from oil and sulfur exploratory wells were used for lithologic descriptions and stratigraphic correlations to supplement data from the Area Characterization wells. Maps of the collection locations for data utilized in analysis are presented in Figures 13-38 and 13-39.

Lithologic descriptions and stratigraphic correlations of the surficial units are based on 35 shallow borings which were drilled in two phases. The first phase consisted of 25 borings drilled to depths less than 61 meters (200 ft). The second phase

[redacted]

BEST DOCUMENT AVAILABLE

AF 12338A

SYSTEM	SERIES	GROUP OR STAGE	FORMATION	AGE MYBP	THICKNESS FEET STUDY AREA	THICKNESS FEET RICHTON DOME	RICHTON DOME LITHOLOGY
QUATERNARY	RECENT		ALLUVIUM		0-125	—	Interbedded variably sandy and silty clays, variably silty sands, and gravels
	?		TERRACE DEPOSITS		0-50	—	Variably clayey quartzose silts with occasional clays and sands.
	PLIO-PLEISTOCENE		CITRONELLE	1.8	0-215	0-215	Lenses and interbeds of variably sandy clays, variably silty sands, and gravels
TERTIARY	MIOCENE		HATTIESBURG AND CATAHOULA undiff.	22.5	849-1991	976-980	Very fine to coarse grained sands, clays, chalky and sandy limestones, and minor shales and siltstones. Includes the *Heterostegina* zone, a chalky, sandy limestone, clay and quartz sand unit
	OLIGOCENE		CHICKASAWHAY		46-215	86-117	Interbedded clays, fine to medium grained sands, and locally very sandy limestones which sometimes grade into limy sands
		VICKSBURG	BUCATUNNA		11-91	43-76	Interbedded clays, fine to medium grained sands, and occasionally mudstones
			VICKSBURG LIMESTONES undiff.		61-240	61-101	Crystalline, sandy, glauconitic, locally chalky or calcarenitic limestones
			RED BLUFF	38	15-123	42-58	Interbedded clays, chalky limestones, and minor dolomites
	EOCENE	JACKSON	YAZOO		112-320	122-178	Glauconitic clays, sandy, chalky limestones or chalky, locally sandy marls underlain by clays and sometimes limy shales
			MOODYS BRANCH	42	10-37	15-18	Locally very sandy, sometimes chalky or glauconitic limestones
		CLAIBORNE	COCKFIELD		78-295	165-224	Clays and sandy, sometimes chalky or glauconitic limestone occasionally interbedded with silty, limy, glauconitic shales.
			COOK MOUNTAIN	44.5	112-280	112-150	Chalky, sandy to silty, sometimes crystalline limestones
			KOSCIUSKO SPARTA	49	121-370	151-218	Interbedded clays, silty, limy shales and sometimes sandy, chalky limestones and slightly limy siltstones
			ZILPHA		46-220	126-170	Clays interbedded with minor limy shales, siltstones, very fine to coarse grained sands and sandy limestones. Abundantly glauconitic.
			WINONA		22-62	33-60	Chalky, sandy, clayey limestones interbedded with limy shales or glauconitic siltstones
			TALLAHATTA	50	123-500	223-306	Clays, sandy, chalky or silty limestones, and silty, limy shales or limy, glauconitic siltstones
	?	WILCOX	WILCOX GROUP undiff.	53.5	1,365-4,955	2,200-2,573	Interbedded fine and very fine grained sands, slightly limy siltstones, silty, locally sandy clays, and minor silty shales, sandy limestones, lignites, and bituminous coal
	PALEOCENE	MIDWAY	PORTERS CREEK		468-1,135	378-470	Interbedded clays, silty sands, slightly fissile shales, and lignites
			CLAYTON		3-37	12-27	Chalky limestones, clays, and silty shales

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
STRATIGRAPHIC CHART
JOB NO. MV9600 TABLE 13-3

consisted of 10 borings drilled to depths of about 152 meters (500 ft) (Figure 13-56). Other data analyzed include field geologic mapping, ground-level resistivity horizontal profiles and vertical soundings, and mineralogical studies of selected samples.

13.3.2.2.1 Stratigraphic Analysis - The formations in the Richton Dome area generally are similar to those of the study area. However, lithologic variations do occur in the Wilcox Group and Tallahatta, Winona, Cook Mountain, and Chickasawhay Formations. The Wilcox Group and the Tallahatta and Winona Formations contain limestone in addition to the rock types characteristic of the region. The limestone is not localized but it is present in these units throughout the near-dome area. Regionally, the Winona Formation consists of clay shales containing chalk or marl lentils (Dinkins, 1967), but in the Richton Dome area it consists of sandy limestone that is variably interbedded with limey shale or glauconitic siltstone. The Cook Mountain Formation consists of sandy limestone interbedded with variable amounts of clay, but it does not contain the shale and sand beds typical of the formation elsewhere. The Chickasawhay Formation of the near-dome area has sands interbedded with the limestone and clay which are regionally typical of that unit.

The Meridian, Forest Hill, Paynes Hammock, and Pascagoula Formations have not been recognized at Richton Dome. They are either not present in this area or they cannot be differentiated on the basis of lithology. As discussed in Section 12.2.2.3.4, the Pascagoula Formation is believed to be absent in the dome area.

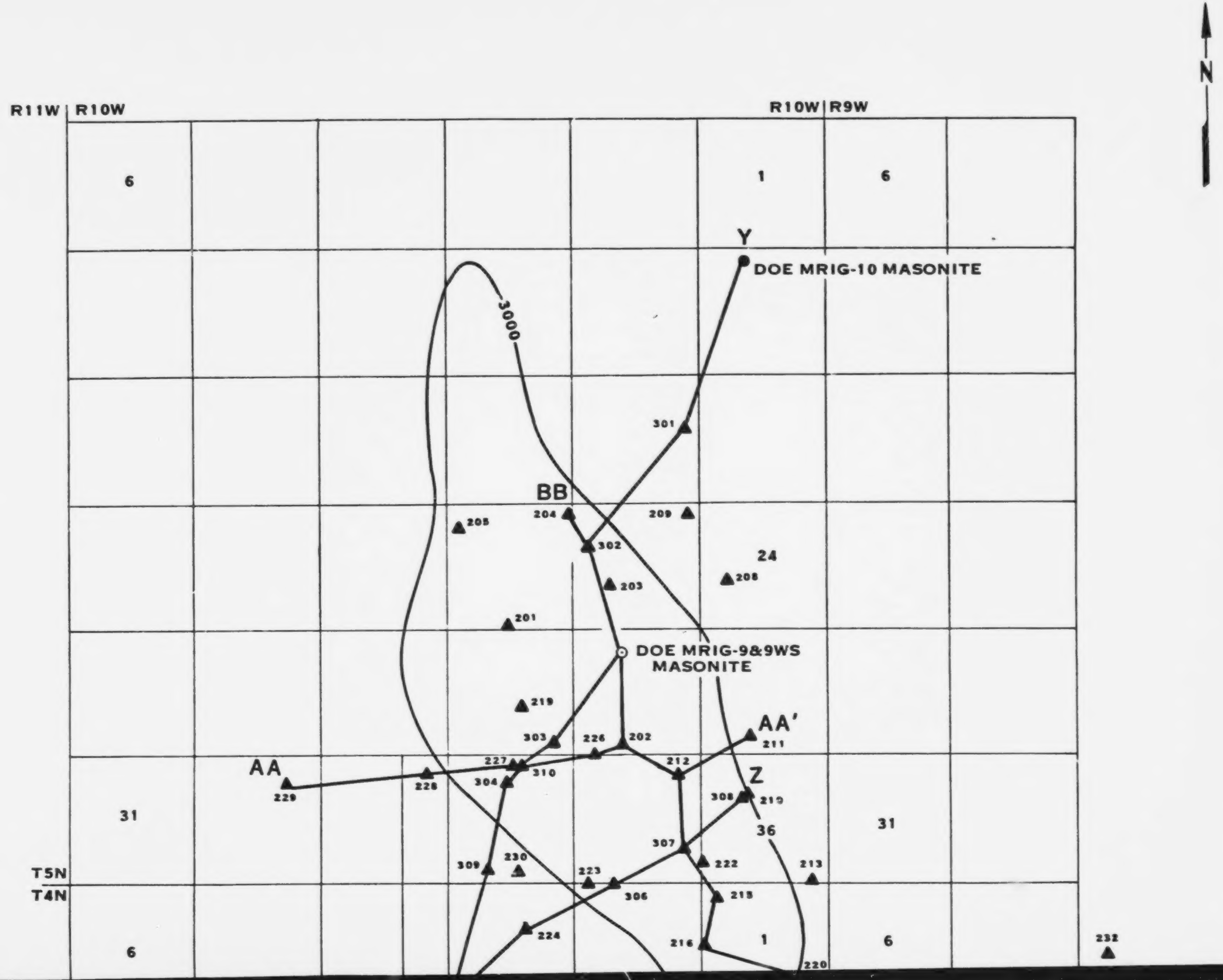
Depressions outlined by the study area structure contour maps (Figures 12-13 through 12-20) may indicate the presence of a rim syncline on the northeastern side of the dome on the Lower Tuscaloosa Formation, Selma Group, Porters Creek, Wilcox, Cook Mountain, Moodys Branch, and Vicksburg Formations (Section 12.2.3). The Selma, Tallahatta, Zilpha, Kosciusko, Winona and Yazoo Formations and the Wilcox Group are thicker in this rim syncline than in other parts of the near-dome area, suggesting that the rim syncline was subsiding during deposition of those sediments.

Formational thicknesses around the dome are, in general, about normal for the study area. In some areas near Richton Dome, however, the Chickasawhay, Cockfield, and the combined Tallahatta and Winona Formations are thicker than normal. For example, these formations immediately overlie a horizon on which the rim syncline is evident. This suggests that subsidence of the rim syncline and contemporaneous dome growth produced thicker accumulations of these formations.

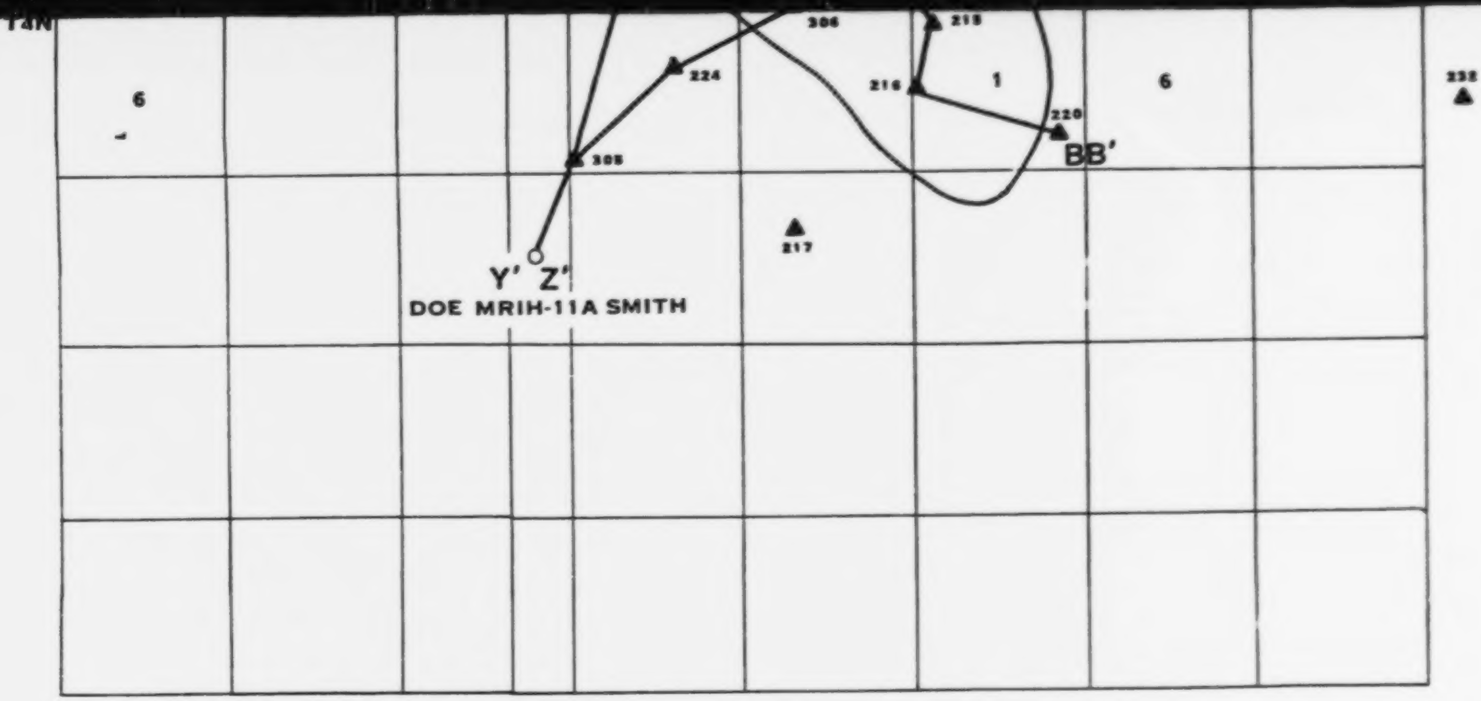
13.3.2.2.2 Stratigraphy of Surficial Units - The surficial geologic units exposed in the Richton Dome area include the Hattiesburg Formation, Citronelle Formation, Quaternary terraces and Quaternary alluvium. The Hattiesburg Formation consists primarily of greenish-gray silty, fine sandy clay, commonly interbedded with lenses of gray silty fine-grain sand, although medium to coarse-grain sand and gravels are found rarely. The unit

233

BEST DOCUMENT AVAILABLE



N
R11W
R10W
R10W
R9W
T5N
T4N
6
1
6
24
31
36
31
6
1
6
3000
Y
DOE MRIG-10 MASONITE
DOE MRIG-9&9WS MASONITE
BB
AA
AA'
Z
301
204
205
209
302
203
208
201
219
303
226
202
211
227
310
212
228
229
304
308
210
307
222
213
309
230
223
306
215
224
216
220
232


T4N
6
306
219
224
216
1
6
232
220
BB'
305
217
Y' Z'
DOE MRIH-11A SMITH

LEGEND

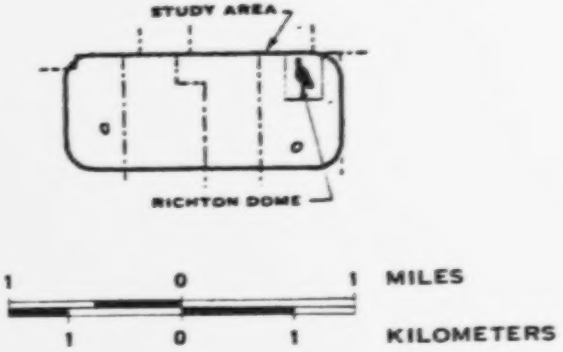
○ AREA CHARACTERIZATION HYDROLOGIC BORING

● AREA CHARACTERIZATION GEOLOGIC BORING

⊙ AREA CHARACTERIZATION SALT CORE BORING

▲ AREA CHARACTERIZATION SHALLOW BORING

—-3000— AREAL EXTENT OF SALT AT -3000 FOOT ELEVATION. DATUM IS MEAN SEA LEVEL.


STUDY AREA
RICHTON DOME
1
0
1
MILES
1
0
1
KILOMETERS

233A

FIGURE 13-56

PREPARED J.D.G. DATE 12-4-81
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED DGP DATE 12/4/81

T-1406-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
LOCATION MAP
SHALLOW GEOLOGIC SECTIONS
Y-Y', Z-Z', AA-AA' AND BB-BB'

JOB NO. MV9600 FIGURE 13-56

BEST DOCUMENT AVAILABLE

weathers to a grayish-tan, nodular, silty, fine sandy clay. Boring samples rarely show lamination or bedding and most outcrops appear massive and have few primary depositional structures. However, some outcrops of the Hattiesburg Formation in the study area have nearly horizontal bedding, with some beds from less than 25 mm (1 in) to about 1.5 meters (5 ft) in thickness.

The Citronelle Formation consists primarily of reddish-brown and yellowish-brown silty coarse to fine-grain sand and gravelly sand with lenses of silt, silty clay, and clay. As much as 66 meters (215 ft) of Citronelle deposits have been penetrated by Area Characterization shallow borings. The Citronelle Formation commonly appears unstratified in boring samples. However, exposures in gravel pits show extensive channelling, scour surfaces, horizontal beds, planar cross beds, intraformational mud clasts, and some festoon cross beds.

Quaternary terraces are observed in the stream valleys of both Bogue Homo and Thompson Creeks and they may extend up some of the major tributaries (Figure 13-54). The lithology of the terraces is very similar to, but more silty than, that of the Citronelle. Colors of the terrace deposits vary from those of the Citronelle Formation and are commonly tan, buff, yellowish brown, or less commonly, reddish brown.

Quaternary alluvium fills the modern stream valleys. An approximate 3-meter (10-ft) thickness of alluvium was encountered in the one boring drilled into the alluvium. Colors vary from tan to grayish tan. The sediments commonly are silty fine-grain

[redacted]

sand, silt, and clay, and sandy gravel composed of quartz and chert. Dark brown organic material occurs in the sediments. Lamination and bedding are rarely observed in boring samples.

13.3.2.3 *Structure*: Richton Dome pierces Jurassic, Cretaceous, and early Tertiary sediments and penetrates some late Tertiary strata. Structural contours of eight Late Cretaceous and Tertiary horizons (Figures 12-13 through 12-20) indicate that the regional strike is generally west-northwesterly. Gravity data show that Richton Dome is located on a major northwesterly-trending salt ridge from which it and the Glazier salt stock have risen. Lower-relief salt structures are present along the axis of the ridge about 6 km (4 mi) northwest of Richton Dome at Tiger Field and about 5 km (3 mi) southeast at Glazier Field. The dome is situated 23 km (14 mi) west of an extensive graben system (Fault Zone F-9 in Section 12.2.3.4.5.9).

Movement of the salt stock has locally disturbed the strata in the surrounding area. Purchased seismic data indicate that Early Cretaceous strata are upturned as much as 213 meters (700 ft) on the western side of the dome (Figure 12-29). Structural relief decreases to approximately 61 meters (200 ft) on late Tertiary strata. On the eastern side of the dome, the seismic data show strata dipping gently towards the dome to within approximately 1.6 km (1 mi) of the domal flank. Seismic data are difficult to interpret close to the dome.

A rim syncline with 91 meters (300 ft) of closure, located approximately 6 km (4 mi) to the north-northwest of the dome, is mapped on top of the Lower Tuscaloosa Formation (Figure 12-13). Closure in the syncline is against the northerly trending fault (F-7) discussed in Section 12.2.3.4.5.7. The rim syncline and fault are recognized on the Selma and Porters Creek contoured horizons. Structural contours of the Wilcox Group and younger strata to the top of the Vicksburg indicate the presence of a depression northeast of the dome with approximately 30 to 61 meters (100 to 200 ft) of closure (Figures 12-16 through 12-20).

Area Characterization high-resolution seismic reflection data indicate the attitude of the strata adjacent to the dome to a depth of approximately -762 meters (-2,500 ft) MSL (Figures 13-46 through 13-49). Eocene through Oligocene strata dip away from the dome on the northeastern and western sides of the dome (Figures 13-47 and 13-49), while strata on the northwestern flank of the dome also dip away from the dome, but not as steeply, and the strata are faulted (Figure 13-48). Maximum structural relief on any of the Tertiary reflectors is approximately 122 meters (400 ft). Faulting is interpreted on the flanks of Richton Dome from these three seismic lines (Figures 13-47 through 13-49). Faulting is evident on the northeastern flank (Figure 13-47) where three faults displace strata from the Wilcox through the Vicksburg. The fault planes dip toward the dome and displacements are approximately 30 to 61 meters (100 to 200 ft), downthrown towards the dome.

Glazier Dome is located about 5 km (3 mi) to the southeast of Richton Dome. Although the Glazier salt stock does not penetrate the top of the Selma, faulting and localized uplift has occurred at the top of the Selma (Figure 12-14). Structure contour maps of younger strata (Figure 12-15 through 12-20) indicate that a closed structural depression is present above Glazier Dome. Its presence at the top of the Vicksburg Formation suggests that movement could have occurred as recently as the Oligocene. This subsidence may be the result of dissolution of the Glazier salt stock or possibly produced by faulting. Another possibility, for which there is little, if any, evidence, is that salt flowed out of the Glazier salt stock possibly into the salt ridge underlying Richton Dome.

Only one major fault has been identified in the Richton near-dome area in addition to the numerous minor faults that have been interpreted from seismic data (Figure 12-29). This fault, F-7, is tangential to Richton Dome and has been described in detail in Section 12.2.3.4.5.7. Gravity data indicate that this fault is underlain by, and parallel with, the deep, elongated salt ridge from which the Richton salt stock developed. The fault has not been identified above the top of the Porters Creek Formation, which may indicate that faulting ceased subsequent to the Paleocene, or it may simply reflect the lack of well control around the dome. It may be significant, however, that the trend of this fault, when projected to the surface, is nearly parallel and coincident with Bogue Homo Creek. Additional data are required to substantiate this fault in younger strata.

Analyses of the Area Characterization shallow boring data indicate the Hattiesburg Formation has a generally westerly strike and dips to the south at about 2 to 11 m/km (10 to 60 ft/mi).

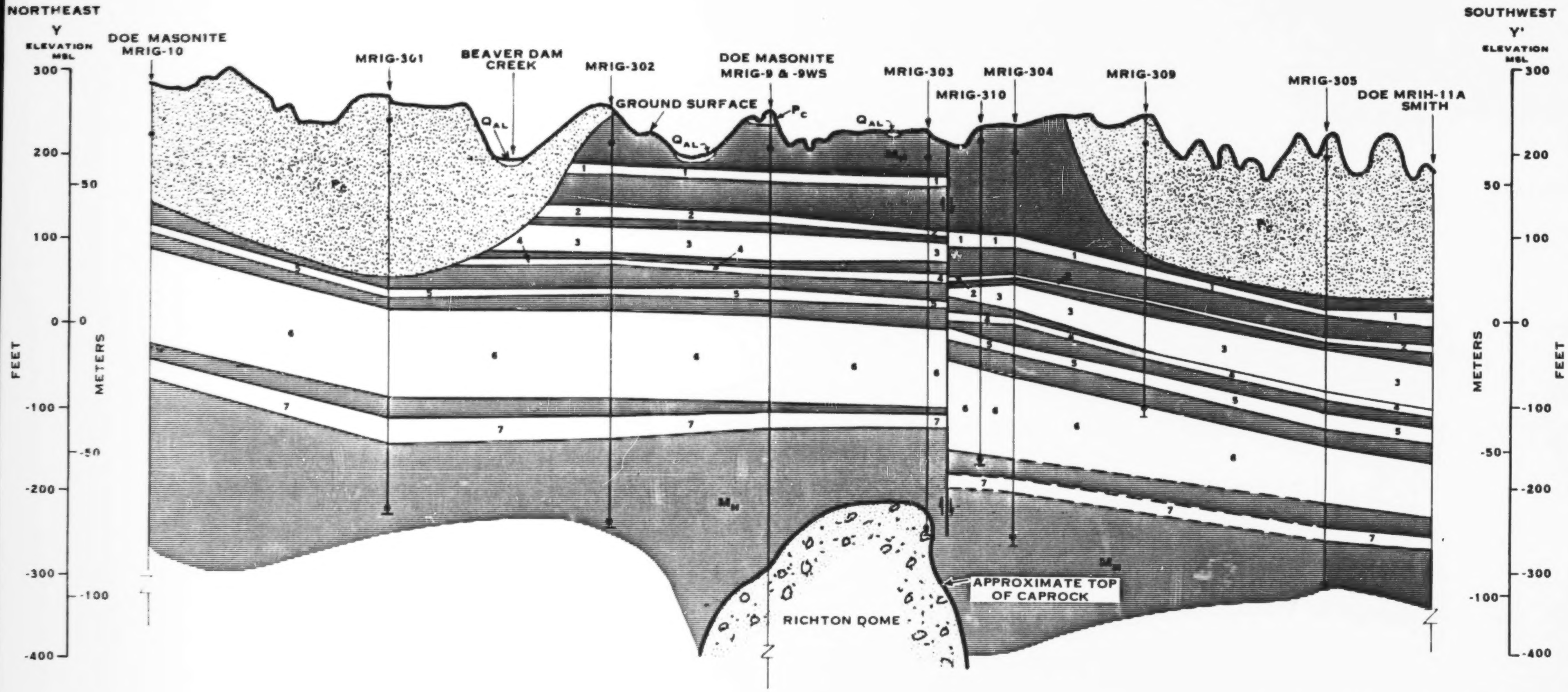
Over the northern half of the supradomal area the Hattiesburg strata are nearly horizontal, although they dip more steeply north and south of the dome (Figure 13-57). The dip of the beds over the southern half of the domal crest is similar to that of the beds away from the crest (Figure 13-58).

Structural analyses of the surficial units indicate domal movement may have occurred as late as Miocene time, as evidenced by the presence of faulting in Hattiesburg strata. Two faults over the dome crest have been identified by geophysical log correlations of strata encountered in the Area Characterization shallow borings. One of these faults displaces Hattiesburg strata approximately 21 meters (70 ft) over the southwestern portion of the dome crest above the -152-meter (-500 ft)-MSL salt contour (Figure 13-57). The other fault was identified in the center of the dome crestal area in the area between the -137 and 152-meter (-450 and -500 ft)-MSL salt contours and displaces the strata about 6 meters (20 ft) (Figure 13-59). Both apparently have downthrown blocks to the south and the faults are about 1.2 km (0.75 mi) apart. Data were insufficient to determine whether faulting continued to the ground surface, what the trends of the faults are, or whether these faults are related to each other or may, in fact, be the same fault. The faulting occurs in areas with a discontinuous Citronelle cover so it was not possible to determine if the faulting affected Citronelle strata.

These faults overlie the break in the slope of the caprock surface, discussed previously in Section 13.3.1, and underlie the divide between the radial drainage and interior drainage discussed in Section 13.3.2.1. These facts, combined with the partial absence of the Citronelle over the northwestern portions of the dome crest (Figure 13-54), provide apparent evidence for uplift of strata over the northern portion of the dome crest. This uplift would initiate faulting as well as the radial drainage discussed previously and would not affect the rather broad flood plain of Pine Branch Creek. These facts suggest that movement of the salt in the northern portion of the dome may have occurred. An alternate possibility is that solution in the caprock caused subsidence, resulting in adjustment of the Miocene strata to the configuration of the caprock by compaction or slippage not related to salt movement.

No clear evidence of domal movement was found on the Hattiesburg-Citronelle contact (Figures 13-57 through 13-61) which slopes to the east and southwest from the domal crest. This slope is apparently a result of channeling of the Hattiesburg surface during deposition of the fluvial Citronelle strata (Figure 13-61). The relief on the contact varies from about 8 meters (25 ft) MSL in the southwest section of the dome area, to a surface exposure of about 79 meters (260 ft) MSL in the northwestern section of the supradomal area (Figure 13-61). Relief on the contact is approximately 49 meters (160 ft) over the domal area. The elevation of the contact varies from 30 meters (100 ft) MSL over the southeastern flank of the dome to 79 meters (260 ft) MSL on the northwestern portion of the domal crest where the Hattiesburg crops out.

BEST DOCUMENT AVAILABLE


NORTHEAST
Y
ELEVATION MSL
DOE MASONITE MRIG-10
MRIG-301
BEAVER DAM CREEK
MRIG-302
DOE MASONITE MRIG-9 & -9WS
MRIG-303
MRIG-310
MRIG-304
MRIG-309
MRIG-305
DOE MRIH-11A SMITH
SOUTHWEST
Y'
ELEVATION MSL
GROUND SURFACE
Q_{AL}
P_C
M_H
1
2
3
4
5
6
7
APPROXIMATE TOP OF CAPROCK
RICHTON DOME
300
200
100
0
-100
-200
-300
-400
50
-50
-100
FEET
METERS

LEGEND

QUATERNARY	☐	Q_{AL}	ALLUVIUM
PLIO-PLEISTOCENE	▨	P_C	CITRONELLE FORMATION
MIOCENE	▤	M_H	HATTIESBURG FORMATION
	▨		CAPROCK
	2		GEO-ELECTRIC UNIT
	⇅		FAULT - ARROWS SHOW DIRECTION OF RELATIVE MOVEMENT
	●		TOP AND BOTTOM OF LOGGED INTERVAL

HORIZONTAL SCALE

2500 0 2500 FEET

0.5 0 0.5 KILOMETERS

VERTICAL EXAGGERATION 25X

SEE FIGURE 13-56 FOR CROSS-SECTION LOCATION

PREPARED J.D.G. DATE 12-4-81
REVISED DATE
REVISED DATE
APPROVED DW DATE 12/7/81

T-1408-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

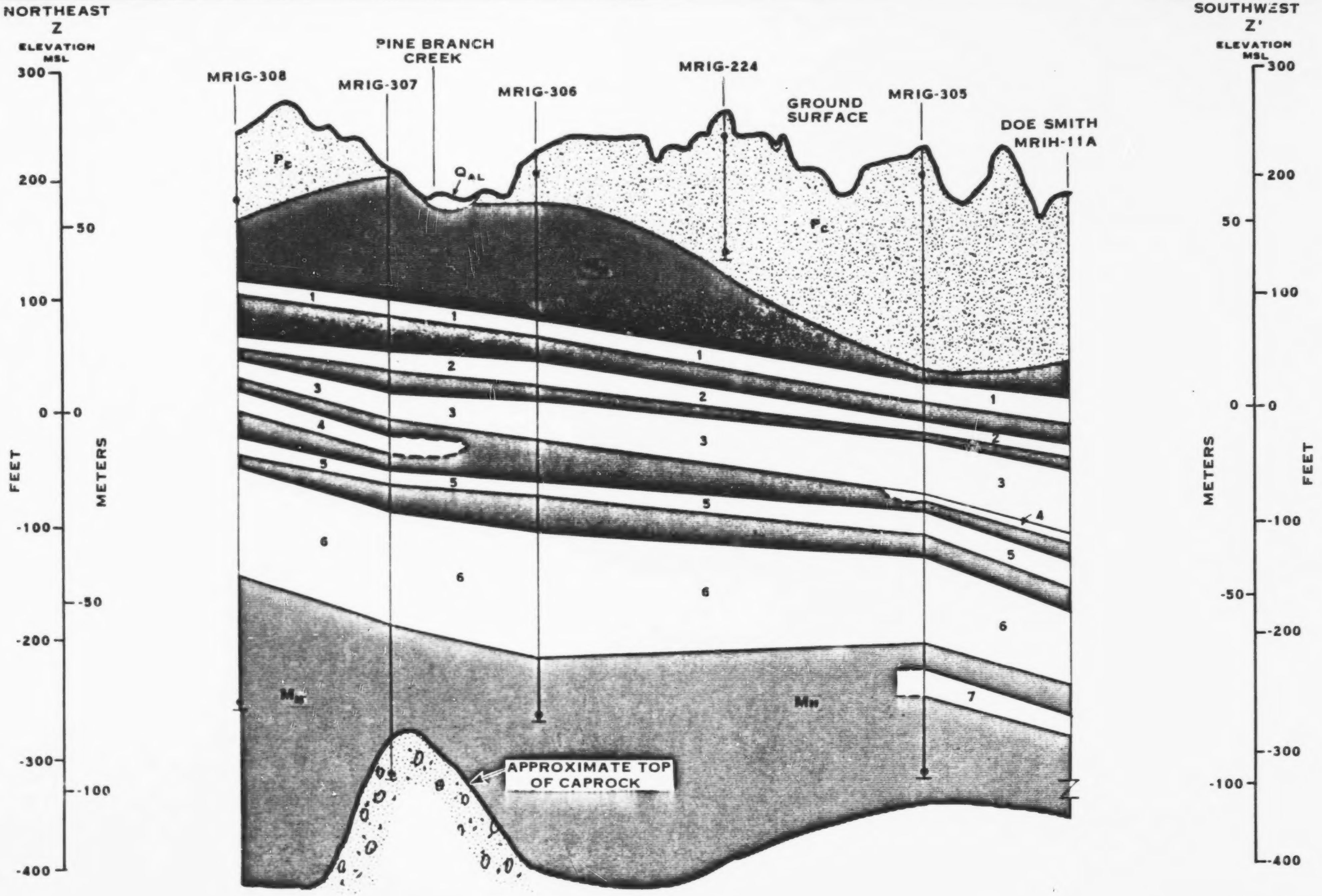
MISSISSIPPI STUDY AREA
RICHTON DOME

SHALLOW GEOLOGIC SECTION Y - Y'

JOB NO. MV9600

FIGURE 13-57

BEST DOCUMENT AVAILABLE


NORTHEAST
Z
ELEVATION MSL
SOUTHWEST
Z'
ELEVATION MSL
FEET
METERS
300
200
100
0
-100
-200
-300
-400
50
0
-50
-100
PINE BRANCH CREEK
MRIG-308
MRIG-307
MRIG-306
MRIG-224
GROUND SURFACE
MRIG-305
DOE SMITH MRIH-11A
P_C
Q_{AL}
M_H
1
2
3
4
5
6
7
APPROXIMATE TOP OF CAPROCK
Z

LEGEND

QUATERNARY	☐	Q_{AL}	ALLUVIUM
PLIO-PLEISTOCENE	▨	P_C	CITRONELLE FORMATION
MIOCENE	▨	M_H	HATTIESBURG FORMATION
	▨		CAPROCK
	2		GEO-ELECTRIC UNIT
	●		TOP AND BOTTOM OF LOGGED INTERVAL

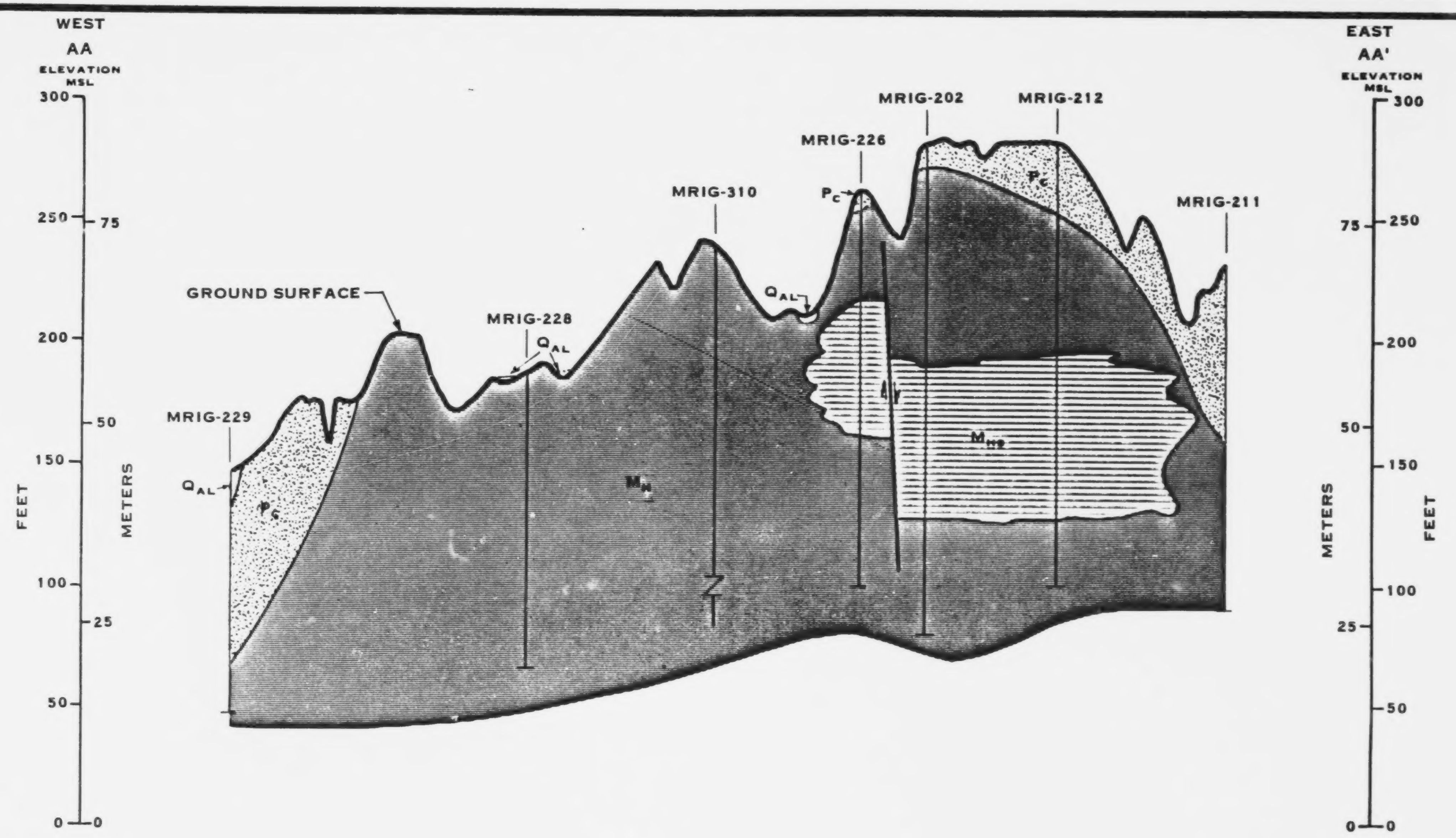
HORIZONTAL SCALE
2500 0 2500 FEET
0.5 0 0.5 KILOMETERS
VERTICAL EXAGGERATION 25X
SEE FIGURE 13-56 FOR CROSS-SECTION LOCATION

PREPARED XDG DATE 12-4-81
REVISED DATE
REVISED DATE 1-[illegible]-81
APPROVED DP DATE 1-[illegible]-81
T-1432-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
SHALLOW GEOLOGIC SECTION Z - Z'
JOB NO. MV9600
FIGURE 13-58

BEST DOCUMENT AVAILABLE


WEST
AA
ELEVATION MSL
300
250
200
150
100
50
0
75
50
25
0
FEET
METERS
EAST
AA'
ELEVATION MSL
300
250
200
150
100
50
0
75
50
25
0
METERS
FEET
MRIG-229
MRIG-228
MRIG-310
MRIG-226
MRIG-202
MRIG-212
MRIG-211
GROUND SURFACE
Q_{AL}
Q_{AL}
Q_{AL}
P_C
P_C
P_C
M_H
M_{HS}

LEGEND

QUATERNARY	☐	Q_{AL}	ALLUVIUM
PLIO-PLEISTOCENE	▨	P_C	CITRONELLE FORMATION
MIOCENE	■	M_H	HATTIESBURG FORMATION
	☰	M_{HS}	HATTIESBURG FORMATION SAND UNIT
	⇅		FAULT - ARROWS SHOW DIRECTION OF RELATIVE MOVEMENT

HORIZONTAL SCALE

2500 0 2500 FEET

0.5 0 0.5 KILOMETERS

VERTICAL EXAGGERATION 50X

SEE FIGURE 13-56 FOR CROSS-SECTION LOCATION

PREPARED J.D.G DATE 12-7-81
REVISED DATE
REVISED DATE
APPROVED DATE 12/4/81

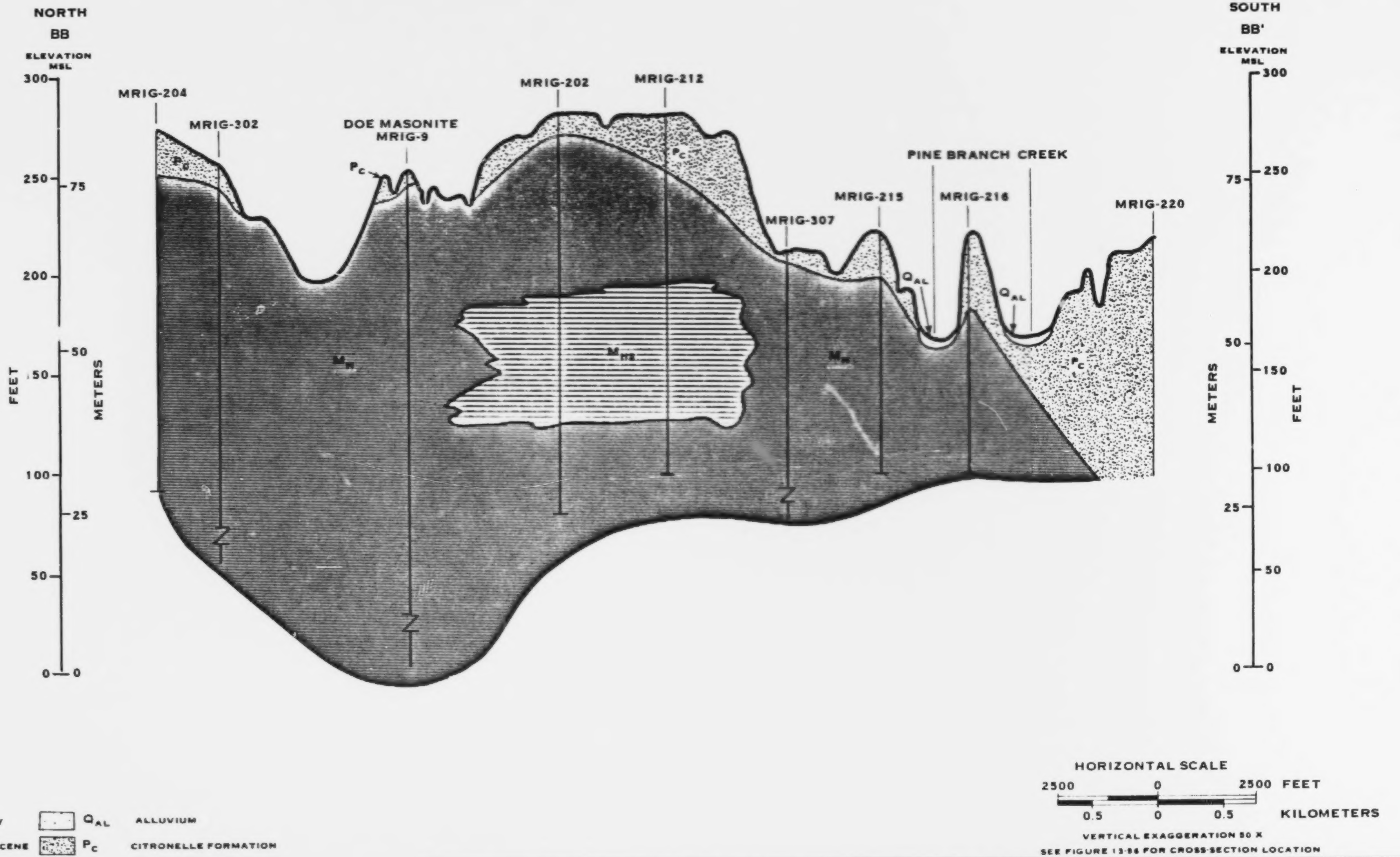
T-1410-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
SHALLOW GEOLOGIC SECTION AA-AA'

JOB NO. MV9600 FIGURE 13-59

BEST DOCUMENT AVAILABLE


NORTH
BB
ELEVATION MSL
SOUTH
BB'
ELEVATION MSL
300
250
200
150
100
50
0
75
50
25
0
FEET
METERS
MRIG-204
MRIG-302
DOE MASONITE MRIG-9
MRIG-202
MRIG-212
MRIG-307
MRIG-215
PINE BRANCH CREEK
MRIG-216
MRIG-220
P_c
Q_{AL}
M_H
M_{HS}
HORIZONTAL SCALE
2500
0
2500
FEET
0.5
0
0.5
KILOMETERS

VERTICAL EXAGGERATION 50 X

SEE FIGURE 13-56 FOR CROSS-SECTION LOCATION

LEGEND

QUATERNARY	░	Q_{AL}	ALLUVIUM
PLIO-PLEISTOCENE	▨	P_C	CITRONELLE FORMATION
MIOCENE	■	M_H	HATTIESBURG FORMATION
	▤	M_{HS}	HATTIESBURG FORMATION SAND UNIT

PREPARED J.D.G. DATE 12-4-81
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE 1/14/82

T-1411-1

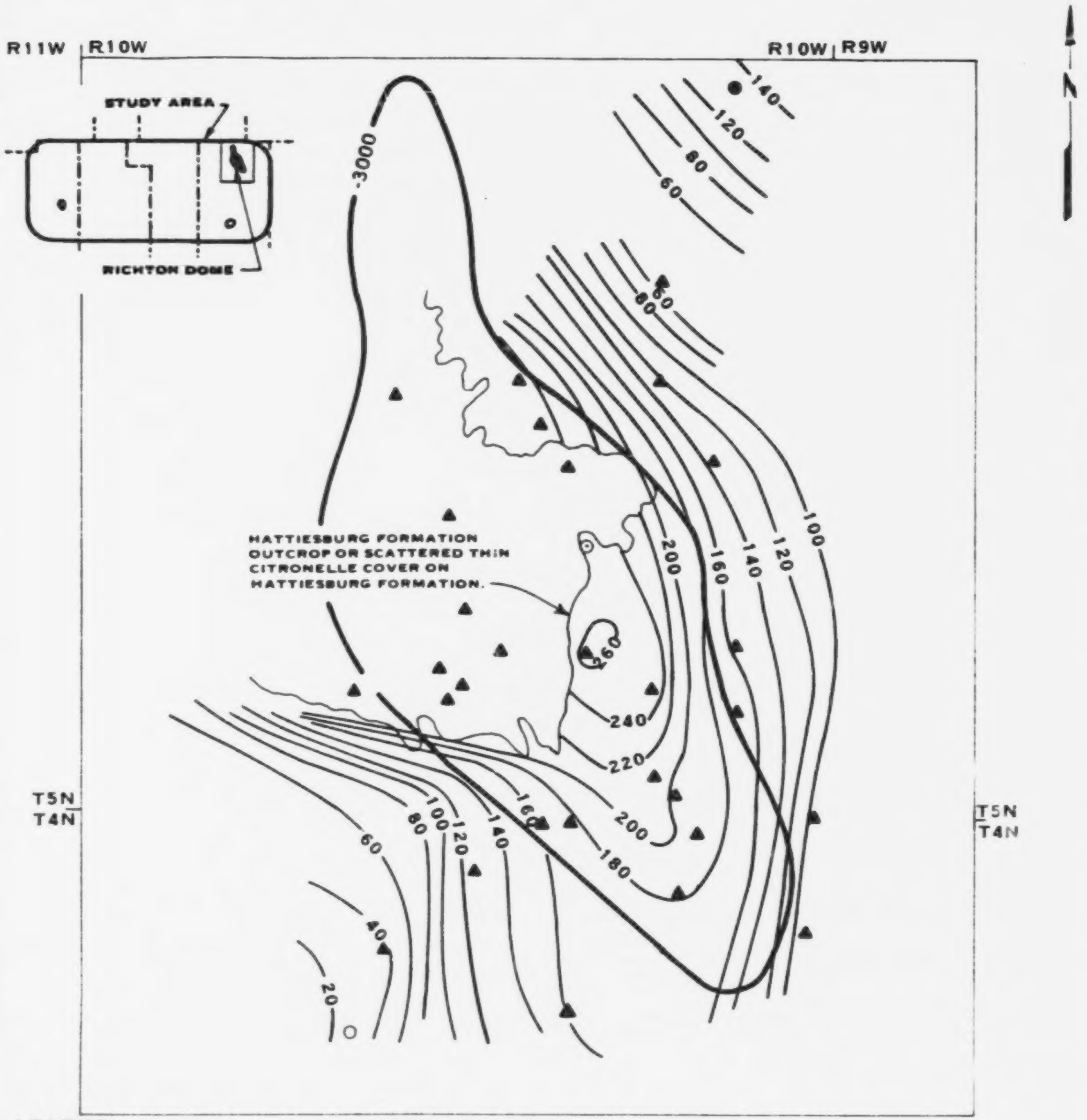
NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOME
SHALLOW GEOLOGIC SECTION BB - BB'

JOB NO. MV9600 FIGURE 13-60

AF 12338A


R11W
R10W
R10W
R9W
STUDY AREA
RICHTON DOME
T5N
T4N
T5N
T4N
-3000
140
120
80
60
80
60
200
160
140
120
100
260
240
220
200
180
160
140
120
100
80
60
40
20
HATTIESBURG FORMATION OUTCROP OR SCATTERED THIN CITRONELLE COVER ON HATTIESBURG FORMATION.

LEGEND

○ AREA CHARACTERIZATION HYDROLOGIC BORING

● AREA CHARACTERIZATION GEOLOGIC BORING

⊙ AREA CHARACTERIZATION SALT CORE BORING

▲ AREA CHARACTERIZATION SHALLOW BORING

—140— STRUCTURE CONTOUR · SHOWS ELEVATION OF TOP OF HATTIESBURG FORMATION

—-3000— LINE OF EQUAL ELEVATION OF SALT. IN FEET. DATUM IS MEAN SEA LEVEL.

1 0 1 MILES

1 0 1 KILOMETERS

CONTOUR INTERVAL 20 FEET

PREPARED J.DG DATE 12-4-81 REVISED ______ DATE ______ REVISED ______ DATE ______ APPROVED DG DATE ~~-1~~-14-82 T-1407-1	NATIONAL WASTE TERMINAL STORAGE PROGRAM GEOLOGIC EVALUATION GULF COAST SALT DOMES LAW ENGINEERING TESTING COMPANY MARIETTA GEORGIA	MISSISSIPPI STUDY AREA RICHTON DOME STRUCTURE CONTOUR MAP - TOP OF HATTIESBURG FORMATION JOB NO. MV9600 FIGURE 13-61

244

BEST DOCUMENT AVAILABLE

Absence of the Citronelle Formation over the northwestern portion of the supradomal area, discussed previously as possible evidence of domal uplift, could also be attributed to nondeposition or erosion of Citronelle sediments in that area. The Citronelle age stream valleys (Figure 13-61), which are approximately parallel to the northeastern and southwestern flanks of the dome, did not erode the Hattiesburg Formation as deeply, if at all, in the northwestern portion. This area may have been a topographic high during the time these streams were active, or it may have been undergoing uplift during this period, thus affording additional evidence of uplift over the northern portion of the dome.

13.3.3 MINERAL RESOURCES: Proven mineral resources in the Richton Dome area include sand and gravel, from the numerous gravel pits in the area, and oil and gas from fields which extend into the periphery of the domal area. Several gravel pits, including one which covers approximately 0.38 km^2 (0.15 mi^2), are located in in the Citronelle Formation as well as in Quaternary terrace and alluvial deposits. Sand and gravel have low potential for development except for local use because of the abundance of these materials in the region. Clay is present near the dome in potentially useable quantities in the Hattiesburg Formation. The quality of the clay is not known and it has not been produced yet in the dome area. Petroleum and sulfur exploration has also been conducted in the vicinity of Richton Dome without success.

13.3.3.1 Hydrocarbons: Production of petroleum in the Richton Dome area has been from wells in Glazier and Tiger Fields, discussed previously in Sections 12.3.1.7 and 12.3.1.8. Glazier Field, located approximately 5 km (3 mi) southeast of the dome, produces oil and limited quantities of gas from the Lower and Upper Tuscaloosa Formations (Figure 12-33). Both of the producing wells in Glazier Field are within the Richton Dome area. Cumulative production in these two wells from December 9, 1954, to December 31, 1979, consisted of 99,945 m^3 (628,584 bbl) of oil and 83,374,080 liters (2,944,000 ft^3) of gas. Production in 1979 consisted of 1,927 m^3 (12,120 bbl) of oil.

Tiger Field is located approximately 5 km (3 mi) northwest of Richton Dome. Two of the four wells in the field, which are operated by the Union Producing Company and produce from the Hosston gas reservoir, are within the near-dome area. Production from these two wells, from their completion in 1975 to December 31, 1979, has amounted to 20,834 m^3 (131,030 bbl) of oil and 12,672,860,000 liters (447,488,000 ft^3) of gas. Production from the two wells in the dome area in 1979 was 10,148 m^3 (63,828 bbl) of oil and 6,656,134,000 liters (235,033,000 ft^3) of gas (Mississippi State Oil and Gas Board, 1980).

Several petroleum exploration wells have been drilled and abandoned in the domal area with no production being reported. Murray (1979), after consideration of local and regional stratigraphy, structure, and production trends, rated the potential for discovery of additional petroleum resources in the vicinity of Richton Dome as being speculative to highly speculative. He indicated that future discoveries within 3 km (2 mi) of the dome flanks would most likely be within 305 and 457 meters (1,000 to 1,500 ft) of the salt-sediment interface, and they would be limited to 79,500 m^3 (500,000 bbl) of oil and gas equivalent or less.

13.3.3.2 Sulfur: During late 1944 and early 1945, 34 sulfur test wells were drilled by Exploro Corporation, later called Minsearch Corporation (Figure 13-39 and Table 12-2). Thirty of these tests drilled into the caprock with no reported sulfur production. Murray (1979) rated the possibility of development of hydrogen sulfide gas and sulfur from caprock as speculative.

13.3.3.3 Mineral Resource Potential: The resource potential of several additional commodities, which could be extracted from an area within 3 km (2 mi) of the flanks of Richton Dome, were also evaluated by Murray. In this study, the potential of the following commodities or activities were rated better than fair for development.

(1) Brining, excellent
(2) Underground storage, good to excellent
(3) Recreation and general use, good to excellent
(4) Agricultural products and farming, fair to good.

Commodities rated as having a fair potential for development are:

(1) Heavy minerals
(2) Sand and gravel (for local use)

(3) Geothermal or geopressured materials (used locally and developed as a by-product of a more economic commodity)

(4) Carbon dioxide

(5) Construction materials.

However, in the context of current economics and marketability, none of the known commodities are considered to have an encouraging potential.

13.4 SUMMARY OF SELECTED DOMES

The geologic characterization of selected salt domes within the study area included Cypress Creek, Lampton, and Richton Domes. The studies focused on the area within a 8-km (5-mi) radius of each dome. Because of land access problems in the Lampton Dome area, data collection there was curtailed. Plans for drilling into and around the Lampton Dome had to be abandoned, as did gravity surveys, terrace mapping, and high-resolution seismic surveys over the dome proper.

The three candidate domes were modeled by computer by using both gravity, seismic and existing well data to determine their size and shape. The models were used to calculate the area at -610, -762, and -914 meters (-2,000, -2,500 and -3,000 ft) MSL.

Studies have determined that the three candidate domes are in a burial stage of development, as discussed in Chapter 2 (Volume I). Limited studies of Pleistocene terraces at Cypress Creek and Richton do not indicate dome growth at these two domes during the Quaternary Period, which involves about 2 million years. For this reason, and because none of the mechanisms postulated to control dome growth are active either regionally or locally, it appears that the candidate domes are permanently stabilized.

The topic of mineral resources was evaluated by analyses of available and purchased data and by special reports. An expert consultant specializing in the regional evaluation of mineral resources was retained to assess potential reserves in proximity to the candidate domes. This evaluation compared the domes according to known or potential economic deposits which would become unavailable if a repository were constructed.

None of the Mississippi candidate domes are considered to have significance for future mineral production. The potential for future hydrocarbon production at Cypress Creek is considered greater than at Lampton or Richton Domes only because productivity has been demonstrated. Although current production at Cypress Creek Dome is steady, it is relatively small.

13.5 LIST OF REFERENCES CITED

Anderson, R. E., Eargle, D. H., and Davis, B. O., 1973, Geologic and hydrologic summary of salt domes in Gulf Coast region of Texas, Mississippi, and Alabama: U.S. Geological Survey, Open-File Report USGS-4339-2, 294 p.

Bowen, R. L., 1979, *in* Paulson, O. L., Jr., Bowen, R. L., Sundeen, D. A., and Hoskin, C. M., Terrace Mapping I, Cypress Creek Salt Dome Perry County, Mississippi: unpublished report prepared for Law Engineering Testing Company, Gulf Coast Salt Dome project, 46 p.

Bowen, R. L., 1980, *in* Paulson, O. L., Jr., Bowen, R. L., and Froelicher, F., Terrace mapping II Richton Salt Dome Perry County, Mississippi: unpublished report prepared for Law Engineering Testing Company, Gulf Coast Salt Dome project, 22 p.

Columbia, Mississippi Chamber of Commerce, 1980, telephone conversation of April 14, 1980 initiated by Law Engineering.

Dinkins, T. H., Jr., 1967, Subsurface stratigraphy of George County, *in* Williams, C. H., Jr., Dinkins, T. H., Jr., and McCutcheon, T. E., George County geology and mineral resources: Mississippi Geological Survey, Bulletin 108, 191-227.

Karges, H. E., 1975, Petroleum potential of Mississippi shallow salt domes: Gulf Coast Association of Geological Societies, Transfactions, V. 25, pp. 168-181.

May, J. H., 1974, Wayne County geology, *in* May, J. H., and others, Wayne County geology and mineral resources: Mississippi Geological Survey Bulletin 117, pp. 13-194.

Mellen, F. F., 1979, Mineral resources of Cypress Creek Dome, T2N, R10W, Perry County, Mississippi: unpublished report prepared for Law Engineering Testing Company, Gulf Coast Salt Dome project, 12 p.

Mississippi Geological Survey, 1969, Geologic map of Mississippi, scale 1:500,000.

Mississippi State Oil and Gas Board, 1980, Annual Report-1979, no. 4 v 80.

Murray, G. E., 1979, Report on dome mineral resources; unpublished report prepared for Law Engineering Testing Company, Gulf Coast Salt Dome project, 73 p.

Paulson, O. L., Jr., Bowen, R. L., and Froelicher, F., 1980, Terrace mapping II Richton Salt Dome Perry County, Mississippi: unpublished report prepared for Law Engineering Testing Company, Gulf Coast Salt Dome project, 22 p.

U.S. Bureau of the Census, Census of population, 1970, General population characteristics, Mississippi, final report PC(I)-B26, p. 40.

U.S. Geological Survey, 1947, Topographic maps, Beaumont and New Augusta, Mississippi, Scale 1:63,360.

U.S. Geological Survey, 1964, Topographic maps, Ovett, Ovett S. E., Rhodes and Richton, Mississippi, Scale 1:24,000.

U.S. Geological Survey, 1969, Topographic map, Pinebur, Mississippi, Scale 1:24,000.

U.S. Geological Survey, 1970, Topographic maps, Columbia, North and Columbia, South Mississippi, Scale 1:24,00.

U.S. Geological Survey, 1974, Topographic map, Improve, Mississippi, Scale 1:24,000.

14 HYDROLOGIC CHARACTERIZATION OF THE MISSISSIPPI STUDY AREA

The purpose of this chapter is to discuss the surface and subsurface hydrology of the study area in general and, more specifically, at selected domes. This treatment is intended to build an information base to aid in the selection of specific domes for further study.

The scope of this chapter includes characterization of the hydrology of the study area, with emphasis on the hydrology around Cypress Creek, Lampton, and Richton Salt Domes. Regional and near-dome surface-water hydrology is described, and preliminary analyses of flooding potential from streams at dome sites are presented. Regional and near-dome ground-water hydrology is also described, and preliminary analyses of estimated average ground-water flow time along vertical flow paths in the subsurface at candidate domes are presented.

The study area, which covers approximately 3,730 km^2 (1,440 mi^2), is located in southern Mississippi (Figure 14-1). It includes parts of the Pascagoula and Pearl River watersheds.

The hydrology of the Mississippi Study Area has been described in regional and statewide reports. Available water-level data were compiled by Lusk (1953) and by Ellison and Boswell (1963). Harvey (1963) and Newcome (1975) have summarized available aquifer-test data. Shows and others (1966) and Taylor and others (1968) describe regional hydrology in and around the study area. The USGS is currently studying the hydrogeology of the study area and in the vicinity of the candidate domes.

A field data-collection program was designed, with the assistance of the USGS, to supplement the existing data base for the study area. This program includes seven hydrogeologic and four geologic data-collection sites. Extensive hydrogeologic data were collected at both the hydrogeologic and geologic data-collection sites. The program also included the collection of surface-water chemistry data around the candidate domes.

14.1 HYDROLOGIC FIELD DATA-COLLECTION PROGRAM

A field program was designed to collect regional as well as near-dome hydrologic data within the study area. The program was designed in consultation with the Mississippi District Office of the Water Resources Division, USGS. The locations of sites where hydrologic data were collected are shown on Figure 14-2.

Data were collected to meet specific objectives which included:

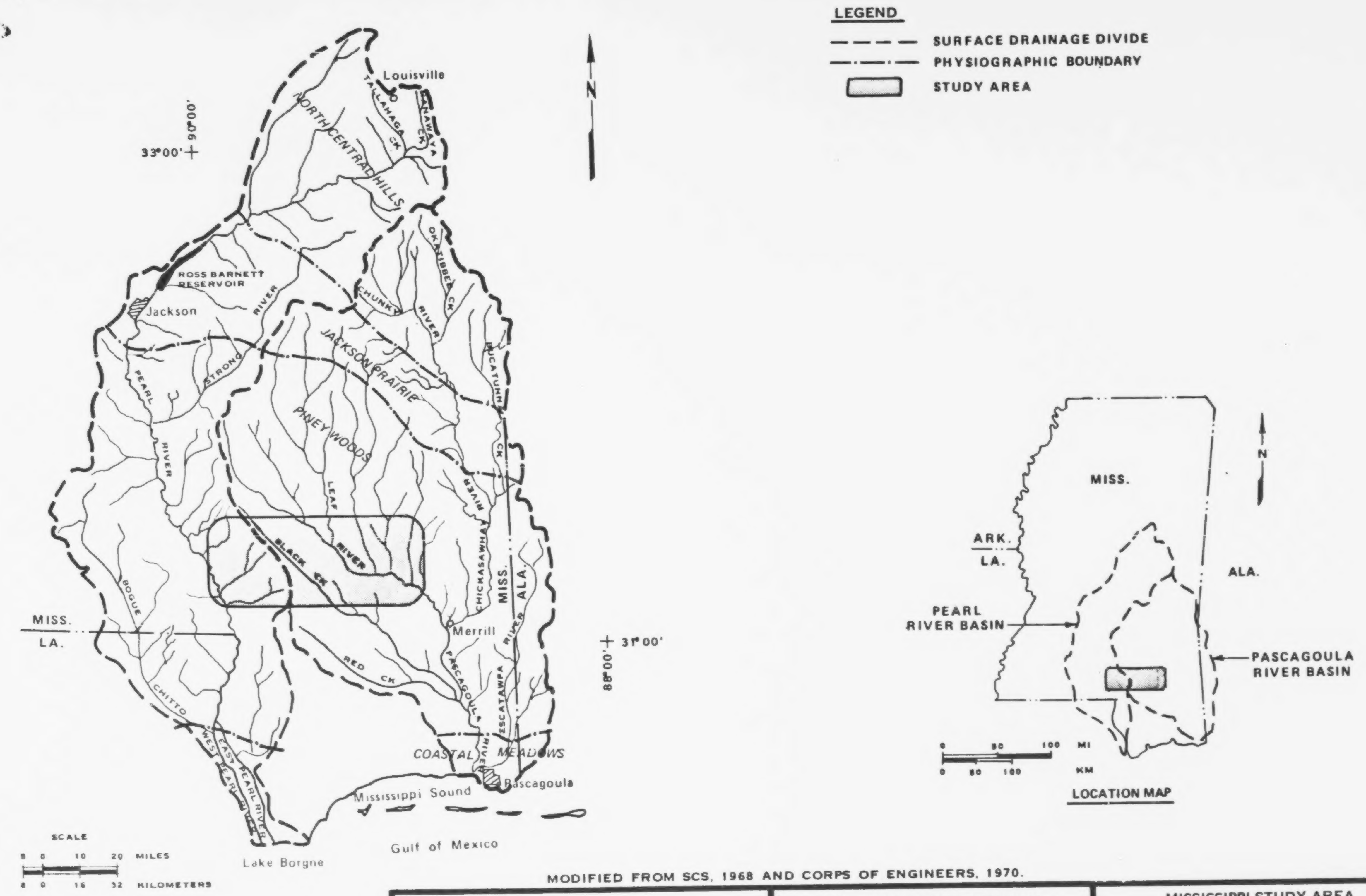
(1) Defining the vertical location, thickness, and lithology of hydrogeologic units in the study area and at candidate domes to a depth of approximately -914 meters (-3,000 ft) MSL

(2) Determining hydraulic properties of these hydrogeologic units

(3) Determining general ground-water flow rates and directions in these hydrogeologic units

(4) Relating chemical composition of ground water in the aquifer system to the flow in the system

(5) Defining hydrogeologic properties of candidate salt domes.


LEGEND
SURFACE DRAINAGE DIVIDE
PHYSIOGRAPHIC BOUNDARY
STUDY AREA
N
Louisville
TALLAHAGA CK
NANAWAYA CK
NORTH CENTRAL HILLS
33°00'
90°00'
ROSS BARNETT RESERVOIR
Jackson
RIVER
STRONG
PEARL
RIVER
CHUNKY RIVER
OKATIBBEE CK
JACKSON PRAIRIE
PINEY WOODS
LEAF
RIVER
BLACK CK
SUCATUNNA CK
CHICKASAWHAY RIVER
MISS.
ALA.
BOGUE
MISS.
LA.
CHITTO
WEST PEARL RIVER
EAST PEARL RIVER
RED CK
Merrill
PASCAGOULA RIVER
ESCATAWPA RIVER
31°00'
88°00'
COASTAL MEADOWS
Pascagoula
Mississippi Sound
Gulf of Mexico
Lake Borgne
SCALE
0 10 20 MILES
0 16 32 KILOMETERS
MISS.
ARK.
LA.
ALA.
PEARL RIVER BASIN
PASCAGOULA RIVER BASIN
N
0 50 100 MI
0 80 100 KM
LOCATION MAP

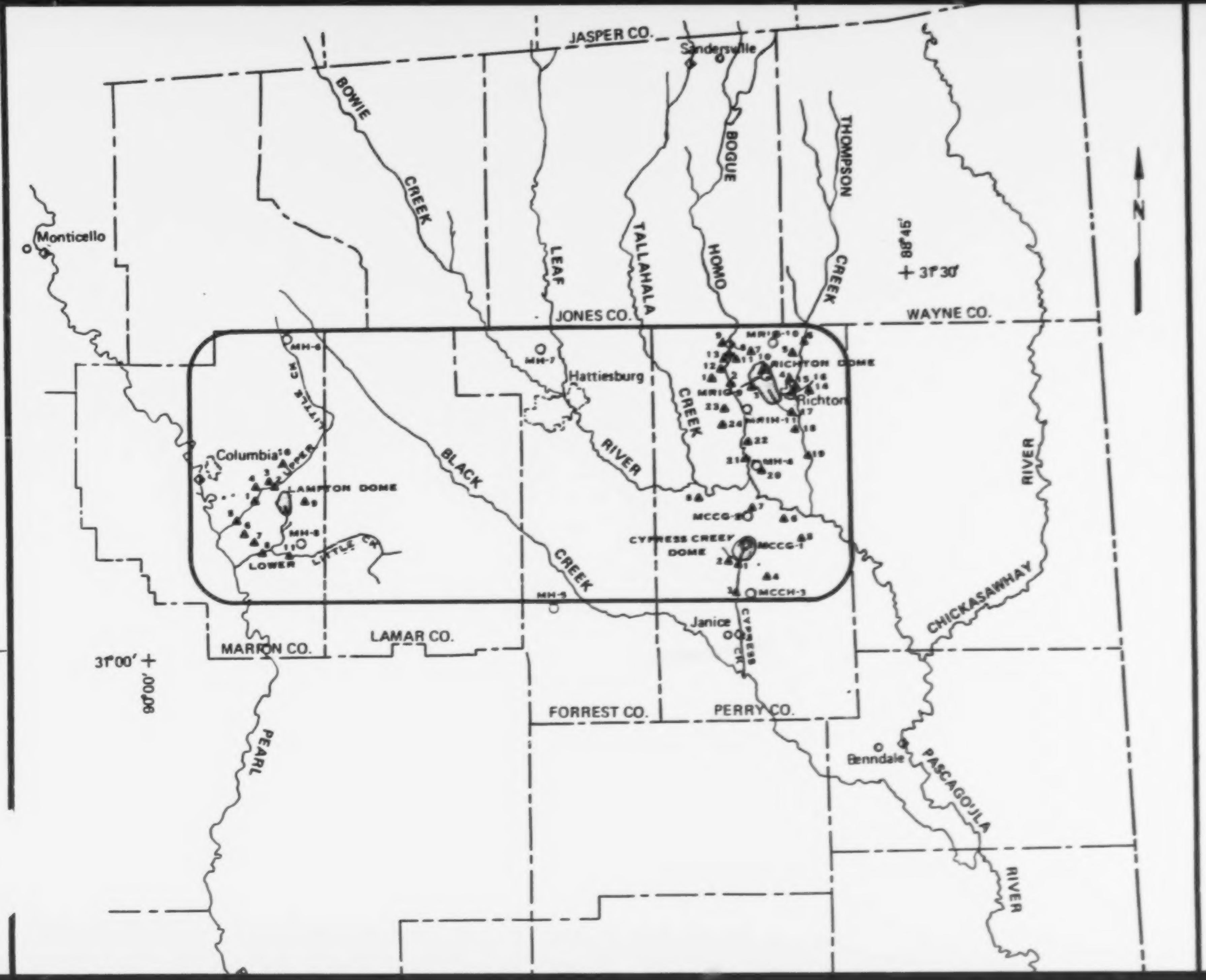
MODIFIED FROM SCS, 1968 AND CORPS OF ENGINEERS, 1970.

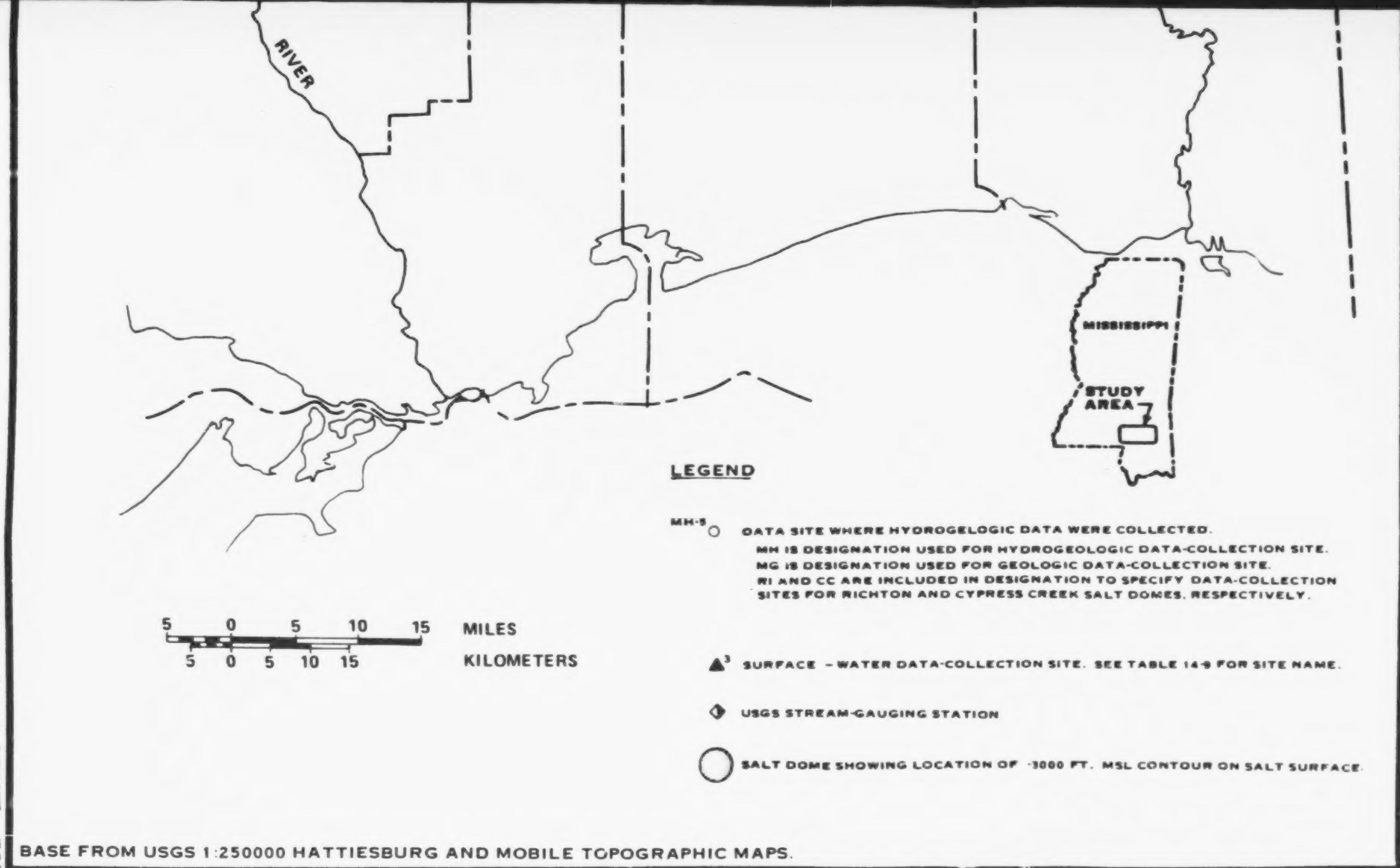
PREPARED RSM DATE 5-30-80
REVISED DATE
REVISED DATE
APPROVED DATE
T-1155-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LOCATION AND EXTENT OF STUDY AREA RELATIVE TO PASCAGOULA AND PEARL RIVER WATERSHEDS
JOB NO. MV9600
FIGURE 14-1

BEST DOCUMENT AVAILABLE


JASPER CO.
Sandersville
BOWIE
CREEK
BOGUE
HOMO
CREEK
THOMPSON
CREEK
LEAF
TALLAHALA
Monticello
N
88°45'
+ 31°30'
JONES CO.
WAYNE CO.
MH-6
MH-7
Hattiesburg
MRIG-10
RICHTON DOME
Richton
MRIG-9
MRIH-11
MH-4
CREEK
RIVER
LITTLE CR
UPPER
Columbia
LAMPTON DOME
MH-8
LOWER
LITTLE CR
BLACK
CREEK
MCCG-2
CYPRESS CREEK DOME
MCCG-1
MCCH-3
MH-5
Janice
CYPRESS CR
RIVER
CHICKASAWHAY
MARION CO.
LAMAR CO.
31°00' +
90°00'
FORREST CO.
PERRY CO.
PEARL
Benndale
PASCAGOULA
RIVER


RIVER
MISSISSIPPI
STUDY AREA
LEGEND
MH-5 ○ DATA SITE WHERE HYDROGELOGIC DATA WERE COLLECTED.
MH IS DESIGNATION USED FOR HYDROGEOLOGIC DATA-COLLECTION SITE.
MG IS DESIGNATION USED FOR GEOLOGIC DATA-COLLECTION SITE.
RI AND CC ARE INCLUDED IN DESIGNATION TO SPECIFY DATA-COLLECTION SITES FOR RICHTON AND CYPRESS CREEK SALT DOMES, RESPECTIVELY.
▲3 SURFACE - WATER DATA-COLLECTION SITE. SEE TABLE 14-9 FOR SITE NAME.
◆ USGS STREAM-GAUGING STATION
○ SALT DOME SHOWING LOCATION OF -3000 FT. MSL CONTOUR ON SALT SURFACE.
5 0 5 10 15 MILES
5 0 5 10 15 KILOMETERS

BASE FROM USGS 1:250000 HATTIESBURG AND MOBILE TOPOGRAPHIC MAPS.

PREPARED	RSM	DATE	5-30-80
REVISED		DATE	
REVISED		DATE	
APPROVED		DATE	8-1-80

T-1156-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

REGIONAL DRAINAGE SHOWING
LOCATION OF HYDROLOGIC DATA-
COLLECTION SITES

JOB NO. MV9600

FIGURE 14-2

BEST DOCUMENT AVAILABLE

14.1.1 SURFACE WATER: No surface-water flow data were collected in the field during this investigation. Information needed for regional and near-dome studies was obtained from published reports or it was computed using standard techniques.

14.1.2 GROUND WATER: Hydrogeologic data-collection sites were chosen to help define hydrogeology in the study area and at the candidate domes. Five sites were selected for collection of regional data. Two were selected for collection of near-dome data, one each in the vicinity of Richton and Cypress Creek Domes.

Multiple deep wells and a water-supply well for drilling operations were drilled at the sites with each separate well completed at a different depth. This made it possible to collect similar data from a number of hydrogeologic units at a site.

Geophysical-log data, aquifer-test data, water-level data and water samples for chemical analysis were collected at each site. Geophysical-log data were collected to help define the vertical location, thickness, and lithology of hydrogeologic units at each site. Aquifer tests were used to obtain data for computing hydraulic properties of hydrogeologic units. Water-level data aid in defining directions and rates of ground-water movement, and water samples help relate the chemical composition of water to flow in the aquifer system.

Hydrogeologic data also were collected at four geologic data-collection sites. Two geologic data-collection sites were located near Richton Dome and two near Cypress Creek Dome. Adequate geologic data were collected from the one deep hole at the geologic data-collection sites. The data included: lithologic samples, geophysical logs, sidewall cores, and geochemical information. The water supply well at each drill site was used to collect additional geologic information.

Sidewall cores were taken from a limited number of wells at selected data-collection sites. These cores were analyzed for porosity, permeability, grain density, and grain-size distribution. A total of 482 sidewall cores were collected in Mississippi.

Methodologies used to collect and analyze data are summarized in the Mississippi Study Area Appendix.

14.1.3 WATER CHEMISTRY: A water chemistry data-collection program was designed to help define the relation of surface water to ground water and directions of ground-water movement. Conductance, pH, dissolved oxygen, and temperature were measured at selected stream locations in the vicinity of the three candidate domes. Water samples were taken from each well at the hydrogeologic and geologic data-collection sites. These samples were analyzed for common ions and selected trace elements. Certain physical properties, such as density, temperature, and pH of the water samples were also determined.

14.2 REGIONAL HYDROLOGIC CHARACTERIZATION

The hydrology of the study area was investigated integrating data from the literature with data collected in the field. An understanding of regional hydrology is an important first step in defining the hydrology in the vicinity of specific domes. The planned size of the study areas was about 2,590 km^2 (1,000 mi^2). In Mississippi the size of the area was enlarged to 3,730 km^2 (1,440 mi^2) in order to encompass the three domes.

14.2.1 REGIONAL SURFACE-WATER HYDROLOGY:

The Mississippi Study Area is located within the two major watersheds of southeastern Mississippi, those of the Pascagoula River and the Pearl River (Figure 14-1). Cypress Creek and Richton Domes are in the Pascagoula River watershed, and Lampton Dome is in the Pearl River watershed.

14.2.1.1 Hydrologic Description of Pascagoula River Watershed:

The Pascagoula River is formed by the confluence of the Leaf and Chickasawhay Rivers near Merrill, Mississippi. It flows southerly from this confluence to enter Mississippi Sound and eventually the Gulf of Mexico.

The Pascagoula River watershed has a temperate. humid climate with short, usually mild winters and long, warm summers typical of the Gulf Coast Region. The mean annual temperature is 19 C (66 F). Mean annual precipitation throughout the watershed is about 1,473 mm (58 in). Average annual runoff from the watershed varies between 432 and 660 mm (17 and 26 in). Average annual runoff in that portion of the watershed above Merrill, Mississippi is about 31 percent of the average annual precipitation (Soil Conservation Service, 1968).

The Pascagoula River watershed is in the physiographic province known as the Gulf Coastal Plain. Four subprovinces are present within this watershed: North Central Hills, Jackson Prairie, Piney Woods, and Coastal Meadows (Figure 14-1). These cross the drainage basin in a northwest-southeast direction (Soil Conservation Service, 1968).

The North Central Hills Subprovince includes the northern tip of the Pascagoula River watershed. This subprovince, which occupies approximately 17 percent of the watershed, is dissected by streams with fairly deep, broad valleys flanked by high, soft-rock ridges and hills whose altitudes vary from 122 to 213 meters (400 to 700 ft) above MSL. Major streams draining this area are the Chunky River and its tributaries, Okatibbee Creek, and Bucatunna Creek, which flow generally southward.

The Jackson Prairie Subprovince, a narrow belt south of the North Central Hills, occupies approximately 13 percent of the watershed. Topography in this area consists of moderately high hills with numerous small prairies interspersed. The topography varies between altitudes of 61 and 152 meters (200 and 500 ft) above MSL and it generally slopes to the south. Bucatunna Creek and the Chickasawhay River traverse this belt in a southerly direction.

Approximately 67 percent of the Pascagoula River watershed is in the Piney Woods Subprovince. The topography of this area is gently rolling, with moderately rugged divides between deep stream valleys. This region slopes to the southeast, varying from altitudes of 61 to 122 meters (200 to 400 ft) above MSL in the north to less than 30 meters (100 ft) in the south. The Leaf River and its tributaries, the lower portion of the Chickasawhay River and the Red and Black Creeks, and the Escatawpa River drain parts of this subprovince. The confluence of the Leaf and Chickasawhay Rivers in the lower portion of the subprovince forms the Pascagoula River.

The remainder of the watershed is in the Coastal Meadows Subprovince, an area of low relief. The topography of this subprovince is gently rolling, sloping southward toward the Gulf Coast. Altitudes vary from 15 to 30 meters (50 to 100 ft) above MSL in the northern portion to near sea level on the coast. The area is drained by the Escatawpa River, a Pascagoula River tributary that flows generally south-southwesterly, and by the Pascagoula River itself, which flows southerly and enters Mississippi Sound at Pascagoula, Mississippi. Ground water lies near the surface in much of this area, as evidenced by wide expanses of marshes and swamps (Soil Conservation Service, 1968).

14.2.1.2 Hydrologic Description of Pearl River Watershed: The Pearl River is formed by the confluence of Nanawaya and Tallahaga Creeks near Louisville, Mississippi. The Pearl River flows generally southwest from this confluence to Jackson, Mississippi, then southerly to the head of its outlet channels, the East and West Pearl Rivers. These rivers empty into Lake Borgne at the Gulf of Mexico.

The Pearl River watershed has a temperate, humid climate with short, usually mild winters and long, warm summers typical of the

Gulf Coast Region. The mean annual temperature over the watershed is 19 C (66 F). Mean annual precipitation is about 1,448 mm (57 in). Average annual runoff varies from 406 mm (16 in) in the upper portion of the watershed to 432 mm (17 in) in the lower portion of the watershed (U.S. Army Corps of Engineers, 1970). Average annual runoff in that portion of the watershed above Jackson, Mississippi is about 29 percent of the average annual precipitation.

The Pearl River watershed is in the same physiographic province and subprovinces as the Pascagoula River watershed (Figure 14-1). The topography of these subprovinces in the Pearl River watershed is similar to that of the Pascagoula River watershed, with ground elevations varying from sea level in the Coastal Meadows Subprovince to approximately 198 meters (650 ft) above MSL in the North Central Hills Subprovince.

There are numerous lakes within the Pascagoula and Pearl River watersheds but only a few of significant size. The largest of these is Ross Barnett Reservoir, which is located on the Pearl River about 10 km (6 mi) northeast of Jackson, Mississippi. This lake, with a normal surface area of about 12,141 hectares (30,000 acres) and a length of about 69 km (43 mi), has a gross storage volume of 382 hm^3 (310,000 acre-ft). Its primary uses are water supply for the Jackson area and recreation. Other impoundments in the basin range in size from 0.8 to 273 hectares (2 to 675 acres) (Pearl River Vally Water Supply District, 1959).

14.2.2 REGIONAL GROUND-WATER HYDROLOGY: Strata of the Tertiary and Quaternary Periods are of regional hydrologic interest. Tertiary sediments are predominantly interbedded clays and sands which dip southwestward 2 to 9 m/km (10 to 45 ft/mi) and thicken to the southwest, as indicated by isopach maps (Figures 12-21 and 12-22). Surficial Quaternary deposits overlie the Tertiary deposits. Quaternary deposits occur as alluvium in stream valleys and as terrace deposits and they are generally water-bearing. A detailed description of Tertiary and Quaternary sediments and their depositional environments is presented in Chapter 12, Section 12.2.2 of this report.

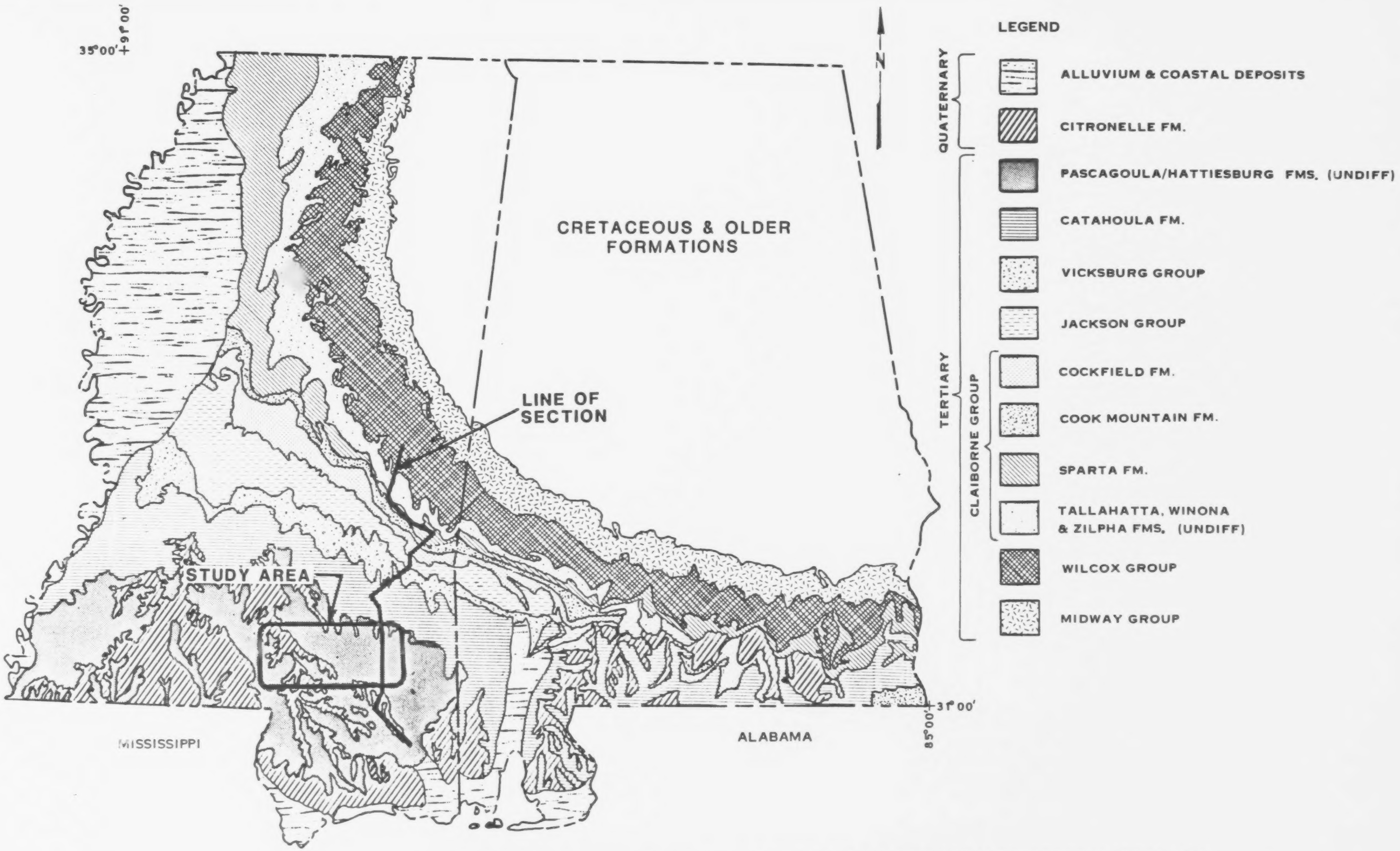
The Citronelle Formation and undifferentiated Hattiesburg and Pascagoula Formations are exposed in the study area (Figure 14-3). Ground-water recharge to these formations is directly from precipitation, and hydraulic connection between these formations and streams is common. The Citronelle and Hattiesburg Formations have been identified in the study area. The Pascagoula Formation has not been found in the parts of the study area mapped by LETCo.

Older units crop out north of the study area in a band that trends northwest to southeast and extends into the coastal plain of Alabama (Figure 14-3). Recharge to these units is derived principally from rainfall in the outcrop areas. Additional recharge may occur as downward leakage in areas south of these outcrops where the potentiometric surface in overlying deposits is greater than that in the underlying deposits.

Piercement salt domes locally affect the dip, strike, and thickness of the geologic beds and these domes may alter the hydrologic characteristics of these units (Taylor and others, 1968). The structural complexities around and over a salt dome may affect its hydrologic relationship with the surrounding and overlying strata.

14.2.2.1 Hydrogeology of the Study Area: Water is present in all of the geologic deposits investigated in this study. The Midway Group is assumed to be the lower limit of the ground-water reservoir for purposes of this study because it contains relatively impermeable beds that hinder the flow of water between overlying and underlying formations, and it is considered a regional confining bed. Also, the Midway Group occurs at depths substantially below those that are generally of interest for proposed storage facilities in salt domes (see Volume I). No hydrologic evidence was found to indicate ground-water leakage through the Midway Group from faulting. The water table in the Quaternary and Miocene deposits is the upper limit of this reservoir.

Hydrogeologic units present in the study area that generally have good water-transmitting properties in southeastern Mississippi include, in ascending order: the Wilcox Group, the Kosciusko (Sparta), Cook Mountain and Cockfield Formations of the Claiborne Group; and the Catahoula, Hattiesburg, and Citronelle Formations (Table 14-1). These deposits contain fresh water in their outcrop areas and for varying distances downdip.


35°00'
90°00'
CRETACEOUS & OLDER FORMATIONS
LINE OF SECTION
STUDY AREA
31°00'
85°00'
MISSISSIPPI
ALABAMA
N
LEGEND
QUATERNARY
TERTIARY
CLAIBORNE GROUP
ALLUVIUM & COASTAL DEPOSITS
CITRONELLE FM.
PASCAGOULA/HATTIESBURG FMS. (UNDIFF)
CATAHOULA FM.
VICKSBURG GROUP
JACKSON GROUP
COCKFIELD FM.
COOK MOUNTAIN FM.
SPARTA FM.
TALLAHATTA, WINONA & ZILPHA FMS. (UNDIFF)
WILCOX GROUP
MIDWAY GROUP
50 0 50 MILES
40 0 40 KILOMETERS

MODIFIED FROM MISSISSIPPI GEOLOGICAL SURVEY, 1976 AND GEOLOGICAL SURVEY OF ALABAMA, 1969.

PREPARED RSM	DATE 5-30-80
REVISED	DATE
REVISED	DATE
APPROVED	DATE [illegible]

T-1157-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

OUTCROP MAP FOR SELECTED
HYDROGEOLOGIC UNITS

JOB NO. MV9500

FIGURE 14-3

BEST DOCUMENT AVAILABLE

TABLE 14-1

GENERALIZED STRATIGRAPHY AND WATER BEARING CHARACTERISTICS OF GEOLOGIC UNITS IN THE MISSISSIPPI STUDY AREA

SYSTEM	SERIES	GEOLOGIC UNIT		DOMINANT LITHOLOGY[1]	WATER BEARING CHARACTERISTICS[2]
QUATERNARY	PLIO PLIESTOCENE	CITRONELLE FORMATION		UNCONSOLIDATED SAND AND GRAVEL, FINE- TO COARSE-GRAINED QUARTZOSE SAND WITH TRACES OF CHERT AND SOME CLAY	TRANSMITS SMALL QUANTITIES OF WATER YIELDS OF WELLS TAPPING THIS AQUIFER ARE GENERALLY SMALL A FEW WELLS CAN PRODUCE UP TO 200 GPM BUT MOST WELLS YIELD 5 25 GPM AQUIFER USE IS PREDOMINANTLY FOR SMALL DOMESTIC WELLS, ALTHOUGH A FEW WELLS PRODUCE ENOUGH FOR MUNICIPAL NEEDS CHEMICALLY, WATER IS LOW IN DISSOLVED SOLIDS AND pH
TERTIARY	MIOCENE	HATTIESBURG AND CATAHOULA FORMATIONS, UNDIFFERENTIATED		INTERBEDDED SAND AND CLAY SAND IS FINE GRAINED AT THE TOP AND GRADES TO COARSE-GRAINED GRANULAR QUARTZ PYRITE IS COMMON THROUGHOUT.	A HIGHLY TRANSMISSIVE WATER BEARING FORMATION AN IMPORTANT SOURCE OF WATER SUPPLY FOR MUNICIPAL, INDUSTRIAL, AND DOMESTIC WELLS IN SOUTHERN MISSISSIPPI PUMPING RATES VARY FROM 125 TO 890 GPM CHEMICALLY, WATER IS LOW IN TOTAL DISSOLVED-SOLIDS.
	OLIGOCENE	VICKSBURG GROUP AND JACKSON GROUP		PREDOMINANTLY CLAY, LIMESTONE, AND MARL, MINOR INTERBEDS OF FINE SAND LIMESTONES VARY FROM CHALKY TO SANDY AND SILTY TO FOSSILIFEROUS	DOES NOT TRANSMIT WATER READILY. ABUNDANCE OF CLAY PREVENTS MOVEMENT OF WATER
	EOCENE	CLAIBORNE GROUP	COCKFIELD FORMATION	CONSISTS OF BEDS OF FINE-TO MEDIUM-GRAINED SAND, SANDY CARBONACEOUS CLAY, AND THIN BEDS OF LIGNITE BEDS OF INTERBEDDED CLAY AND LIMESTONE OCCUR LOCALLY.	HIGH TRANSMISSIVITIES AND HYDRAULIC CONDUCTIVITIES NORTH OF STUDY AREA, WITH YIELDS DECREASING DOWNDIP IN THE STUDY AREA BECAUSE OF HIGH DISSOLVED SOLIDS AND EXCESSIVELY COLORED WATER AQUIFER UTILIZATION IS LIMITED IN THE STUDY AREA
			COOK MOUNTAIN FORMATION	LIMESTONE, VARIABLE CRYSTALLINE TO FOSSILIFEROUS, CONTAINS SOME SAND AND SILT.	GENERALLY NOT CONSIDERED AN AQUIFER, BUT CAN TRANSMIT WATER LOCALLY UTILIZATION IS LIMITED IN THE STUDY AREA DUE TO HIGH SALINITY THIS FORMATION IS USED FOR BRINE DISPOSAL IN SOUTHERN MISSISSIPPI AQUIFER TESTS CONDUCTED BY LETCO SHOW VERY LOW TRANSMISSIVITIES
			KOSCIUSKO (SPARTA) FORMATION	LIMESTONE, CLAY, AND SAND INTERBEDDED UPDIP OF STUDY AREA FORMATION IS COMPOSED PREDOMINANTLY OF ROUNDED QUARTZ GRAINS	GOOD FLUID TRANSMITTING PROPERTIES UPDIP OF STUDY AREA WHERE SPARTA IS EXTENSIVELY UTILIZED FOR PUBLIC AND INDUSTRIAL WATER SUPPLIES DUE TO HIGH SALINITY AND DEPTH OF THE FORMATION UTILIZATION IS LIMITED IN THE STUDY AREA TRANSMISSIVITIES COMPUTED FROM LETCO AQUIFER TESTS SHOW THAT THE SPARTA IS CAPABLE OF TRANSMITTING FLUIDS
			ZILPHA, WINONA AND TALLAHATTA FORMATIONS	ALTERNATING BEDS OF CLAY AND LIMESTONE WITH SOME BEDS OF SILTSTONE AND SHALE. LIMESTONE IS VARIABLE, BUT GENERALLY GLAUCONITIC AND FOSSILIFEROUS	DOES NOT TRANSMIT WATER READILY
		WILCOX GROUP		INTERBEDDED SAND, CLAY AND SILTSTONE, WITH MINOR SHALE, LIMESTONE, AND LIGNITE SAND IS VERY FINE-TO FINE GRAINED	CAPABLE OF TRANSMITTING WATER NORTH OF THE STUDY AREA TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY OF THIS FORMATION IS REDUCED IN THE STUDY AREA DUE TO THE FINE GRAINED CHARACTER OF THE SANDS WATER PRODUCED FROM THIS FORMATION IN THE STUDY AREA IS HIGHLY SALINE AND MAY CONTAIN GAS
	PALEOCENE	MIDWAY GROUP		PREDOMINANTLY CLAY, WITH INTERBEDDED SAND SHALE AND LIGNITE LIGNITE PYRITE, AND GLAUCONITE ARE COMMON THROUGHOUT	DOES NOT TRANSMIT WATER READILY.

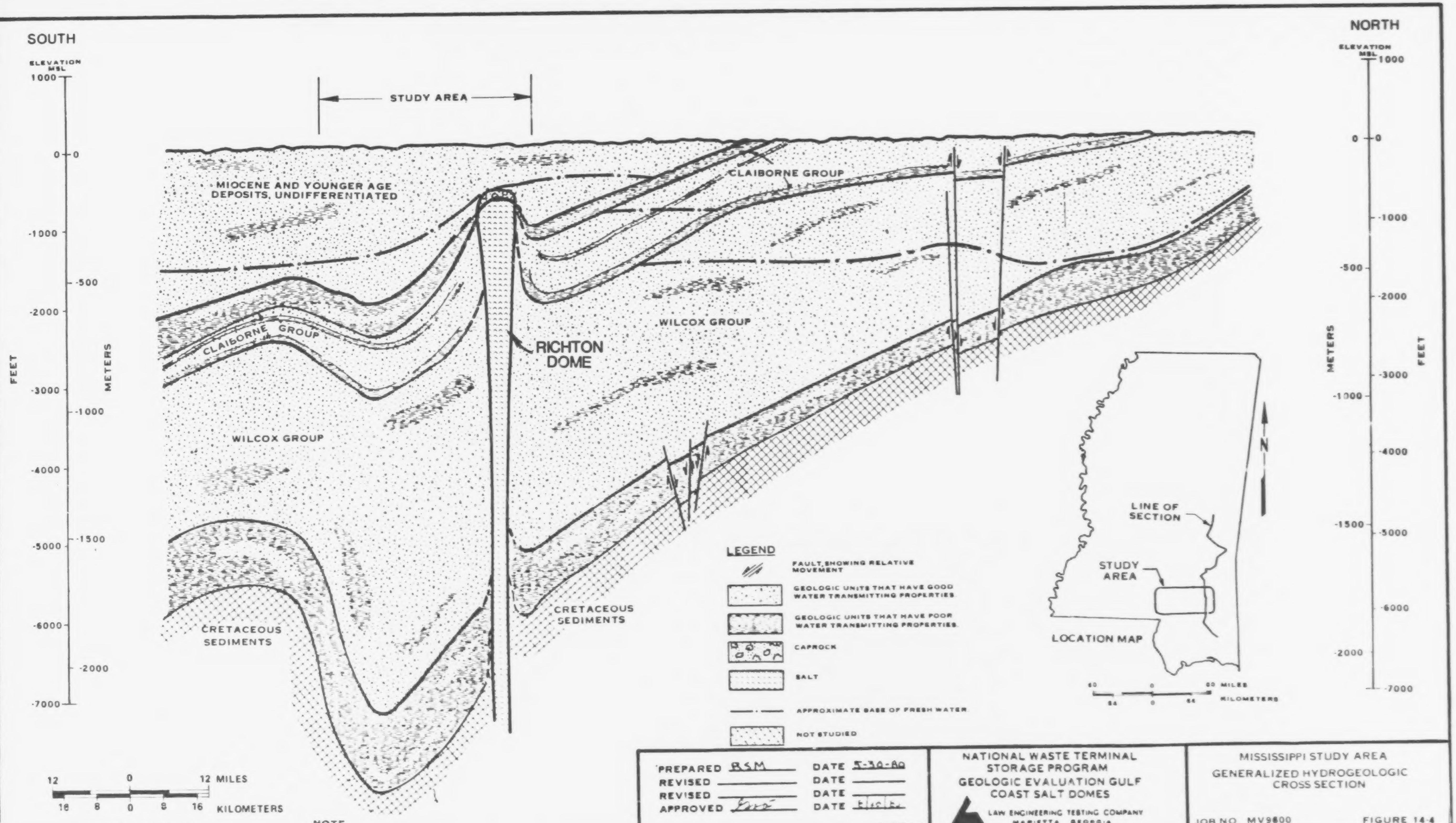
T-1168-0

NOTES: 1. LITHOLOGIC DATA FROM LETCO REGIONAL WELLS.
2. WATER BEARING CHARACTERISTICS FROM LETCO TESTS AND NEWCOMBE, 1971.

BEST DOCUMENT AVAILABLE

Hydrogeologic units present in the study area which generally have poor water-transmitting properties in southeastern Mississippi include: the Midway Group, the Zilpha, Winona, and Tallahatta Formations of the Claiborne Group, and the Vicksburg and Jackson Groups. Although there is not enough information to determine if there are substantial head gradients across the Midway Group, it is believed to retard the movement of ground water. The Claiborne Group also retards the exchange of water between the beds of the Wilcox Group and other units. The exchange of water in beds of the Sparta, Cook Mountain, and Cockfield Formations with water in other units of the aquifer system is retarded by the underlying Claiborne units and the overlying, predominantly argillaceous Vicksburg and Jackson Groups. The generalized relationship between geologic formations having good and poor water-transmitting properties in southeastern Mississippi is illustrated in the generalized downdip hydrogeologic cross section, Figure 14-4.

The aquifer system is divided into a fresh-water zone (water with less than 1,000 mg/l (1,000 ppm) total dissolved-solids content), and various saline-water zones. The surface defined by all points in the aquifer system that have water with 1,000 mg/l (1,000 ppm) in total dissolved-solids varies between elevations of 122 and 488 meters (400 and 1,600 ft) below MSL in the study area (Figure 14-5). Throughout the central and western portions of the area, this surface (the base of the fresh-water zone or, alternatively, the top of the saline-water zone) dips gradually toward the southwest with a slope of approximately 4 m/km (20


SOUTH
NORTH
ELEVATION MSL
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
FEET
METERS
-500
-1000
-1500
-2000
STUDY AREA
MIOCENE AND YOUNGER AGE DEPOSITS, UNDIFFERENTIATED
CLAIBORNE GROUP
CLAIBORNE GROUP
WILCOX GROUP
WILCOX GROUP
RICHTON DOME
CRETACEOUS SEDIMENTS
CRETACEOUS SEDIMENTS
LEGEND
FAULT, SHOWING RELATIVE MOVEMENT
GEOLOGIC UNITS THAT HAVE GOOD WATER TRANSMITTING PROPERTIES
GEOLOGIC UNITS THAT HAVE POOR WATER TRANSMITTING PROPERTIES
CAPROCK
SALT
APPROXIMATE BASE OF FRESH WATER
NOT STUDIED
LINE OF SECTION
STUDY AREA
LOCATION MAP
N
60 0 60 MILES
64 0 64 KILOMETERS
12 0 12 MILES
16 8 0 8 16 KILOMETERS

MODIFIED FROM BICKER 1970

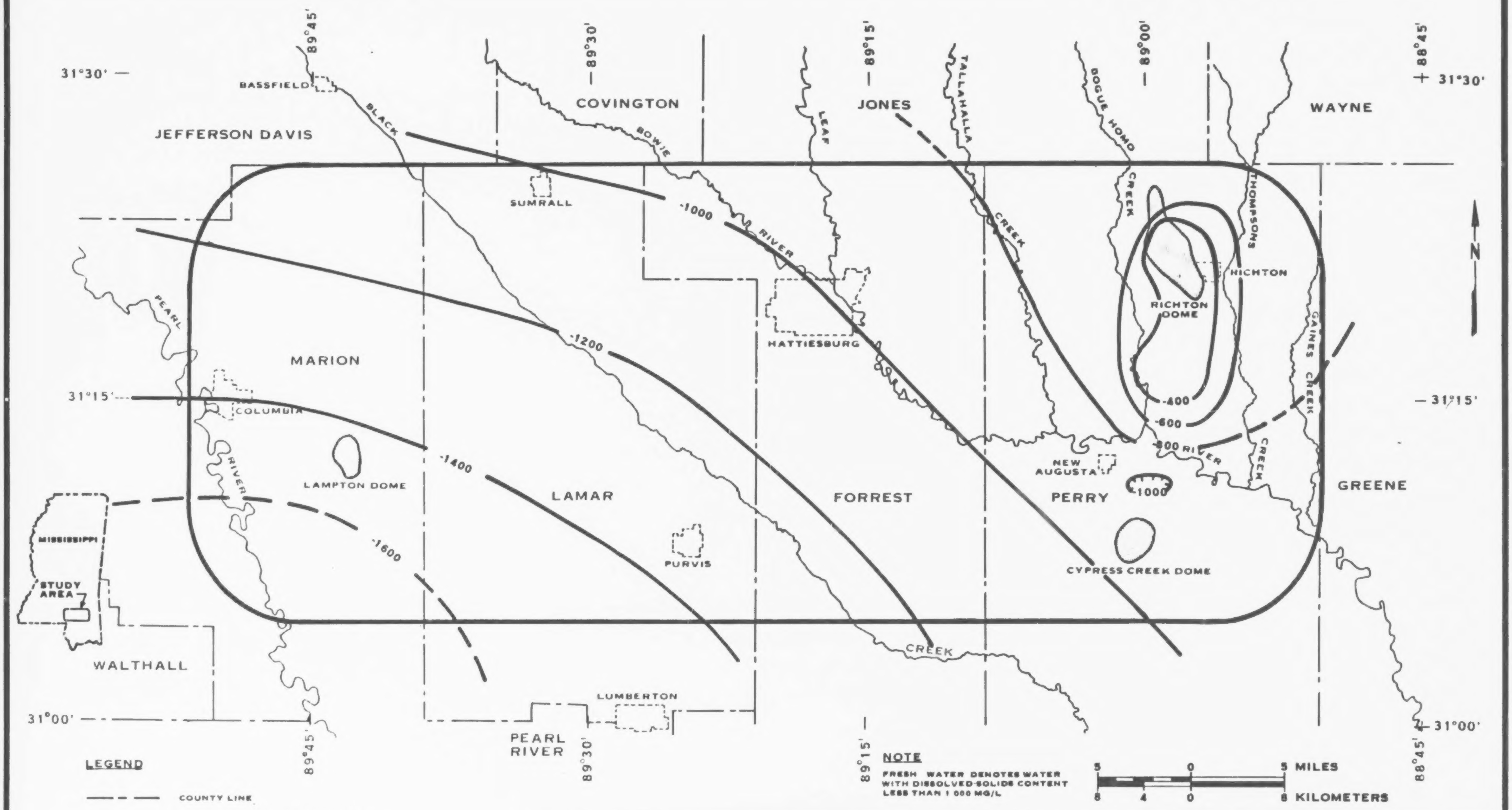
NOTE
VERTICAL EXAGGERATION X 63

PREPARED BSM DATE 5-30-80
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED Ew DATE 6/16/80
T-1158-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
GENERALIZED HYDROGEOLOGIC CROSS SECTION
JOB NO MV9800
FIGURE 14-4

BEST DOCUMENT AVAILABLE


89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
31°15'
31°00'
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
BASSFIELD
SUMRALL
HATTIESBURG
COLUMBIA
PURVIS
LUMBERTON
NEW AUGUSTA
RICHTON
RICHTON DOME
LAMPTON DOME
CYPRESS CREEK DOME
BLACK CREEK
BOWIE RIVER
LEAF RIVER
TALLAHALLA CREEK
BOGUE HOMO CREEK
THOMPSONS CREEK
GAINES CREEK
PEARL RIVER
-1000
-1200
-1400
-1600
-400
-600
-800
-1000
MISSISSIPPI
STUDY AREA
N
5
0
5 MILES
8
4
0
8 KILOMETERS

LEGEND

COUNTY LINE

SALT DOME SHOWING LOCATION OF -3000 FT. MSL CONTOUR ON TOP OF SALT

-1000 BASE OF FRESH - WATER ZONE CONTOUR SHOWS ELEVATION OF BAJE OF FRESH - WATER ZONE. DASHED WHERE INFERRED. CONTOUR INTERVAL 200 FEET. DATUM IS MEAN SEA LEVEL.

NOTE

FRESH WATER DENOTES WATER WITH DISSOLVED-SOLIDS CONTENT LESS THAN 1 000 MG/L

PREPARED	DATE
REVISED	DATE
REVISED	DATE
APPROVED	DATE

T-1444-0

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

BASE OF FRESH-WATER MAP

JOB NO. MV 9600

FIGURE 14-5

BEST DOCUMENT AVAILABLE

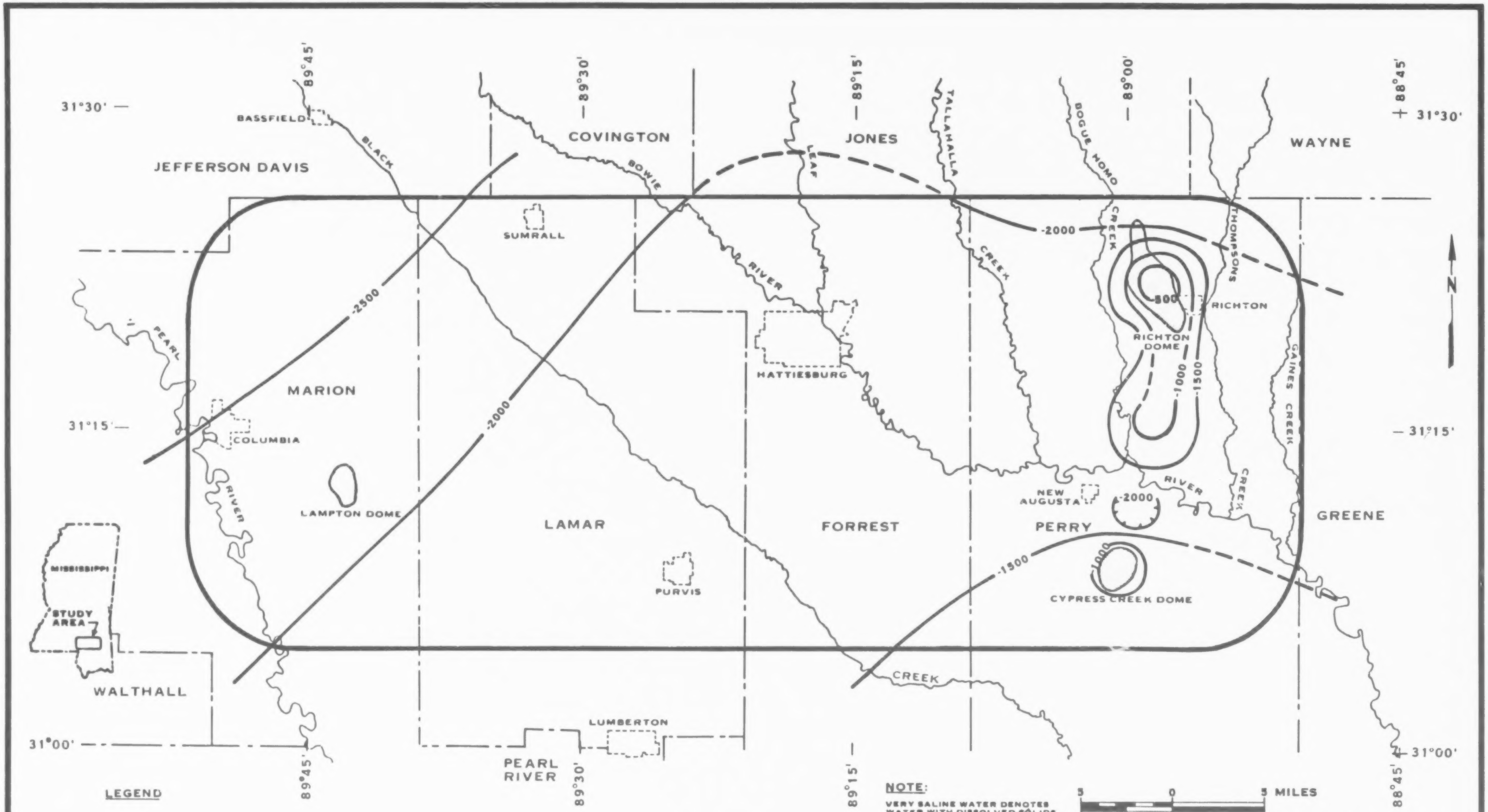
ft/mi), generally following the dip of the sediments. Gradients of the base of fresh water are much steeper in the east in the vicinity of Richton and Cypress Creek Domes. From Richton Dome, where the base of the fresh-water zone is at its highest elevation, downward gradients vary between 5 and 38 m/km (25 and 200 ft/mi) away from the domal area. There is more than one possible explanation for the elevated base of fresh water near the two domes. First is the possible dissolution of the salt. Alternatively, saline water may be moving upward from deeper formations, or the dome may act as a barrier, preventing the flushing of connate saline water from fresh-water aquifers. South of Cypress Creek Dome, the base of fresh water dips southwesterly with a gradual slope of 5 m/km (25 ft/mi). The base of the fresh-water zone in the eastern part of the study area is situated high in the Miocene-age deposits. Elsewhere, the base of the fresh-water zone is generally situated near the base of the Miocene deposits.

The very-saline-water surface [the surface defined by all points in the aquifer system that have water with a total dissolved-solids content of 10,000 mg/l (10,000 ppm)] varies between elevations of 152 and 762 meters (500 and 2,500 ft) below MSL (Figure 14-6). The top of the very-saline-water zone dips northwesterly with a slope of approximately 9 m/km (50 ft/mi) in the west, while in the east this surface has much steeper gradients. The very-saline-water zone surface is at its highest elevation over Richton Dome.

The total dissolved-solids content of the ground water varies gradually with depth from 1,000 to 10,000 mg/l (1,000 to 10,000 ppm) in the zone between the base of fresh water and the top of very saline water.

Results of LETCo aquifer tests (Table 14-2) indicate that sand beds in the Hattiesburg and Catahoula Formations and the Wilcox Group generally have good water-transmitting properties in the study area. The regional hydraulic conductivity for sand beds in the upper Hattiesburg Formation averaged about 45 m/day (150 ft/day), based on the results of aquifer testing at nine sites. This average is within the range for the Miocene in Mississippi determined by the USGS. These values, along with values for other aquifers, were used to determine transmissivity of the aquifer, which is dependent upon the cumulative sand thickness. Cumulative sand thickness varies greatly, but on a regional basis it can be mapped for modeling purposes. The median value of hydraulic conductivity for the Catahoula Formation was about 6 m/day (19 ft/day), somewhat less than the Hattiesburg. The regional hydraulic conductivity for sand beds in the Upper Wilcox Group in the study area was estimated as 8 m/day (25 ft/day), based on six aquifer tests. Aquifer tests in sand beds of the Middle and Lower Wilcox Group gave hydraulic conductivity results close to the estimated regional hydraulic conductivity for the Upper Wilcox Group.

Results of LETCo aquifer tests (Table 14-2) indicate that the sand beds of the Cook Mountain and Sparta Formations generally have poor water-transmitting properties in the study area. The


31°30'
89°45'
BASSFIELD
BLACK
89°30'
COVINGTON
BOWIE
JEFFERSON DAVIS
89°15'
JONES
LEAF
TALLAHALLA
BOGUE HOMO
89°00'
88°45'
31°30'
WAYNE
SUMRALL
RIVER
CREEK
-2000
CREEK
THOMPSONS
N
-500
RICHTON
RICHTON DOME
-1000
-1500
-2500
PEARL
HATTIESBURG
GAINES CREEK
MARION
31°15'
COLUMBIA
-2000
31°15'
RIVER
LAMPTON DOME
LAMAR
FORREST
NEW AUGUSTA
-2000
RIVER
CREEK
PERRY
GREENE
MISSISSIPPI
STUDY AREA
-1500
-1000
PURVIS
CYPRESS CREEK DOME
WALTHALL
CREEK
LUMBERTON
31°00'
PEARL RIVER
89°45'
89°30'
89°15'
88°45'
31°00'
5
0
5 MILES
8
4
0
8 KILOMETERS

LEGEND

— - —	COUNTY LINE
O	SALT DOME SHOWING LOCATION OF -3000 FT. MSL CONTOUR ON TOP OF SALT
— -500 —	VERY SALINE - WATER ZONE CONTOUR. SHOWS ELEVATION OF TOP OF VERY SALINE - WATER ZONE. DASHED WHERE INFERRED. CONTOUR INTERVAL 500 FEET. DATUM IS MEAN SEA LEVEL.

NOTE:
VERY SALINE WATER DENOTES WATER WITH DISSOLVED-SOLIDS CONTENT GREATER THAN 10,000 MG/L

PREPARED	[illegible]	DATE	9/18/80
REVISED		DATE	
REVISED		DATE	
APPROVED	[illegible]	DATE	8/20/80

T-1445-0

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
TOP OF VERY SALINE-WATER MAP

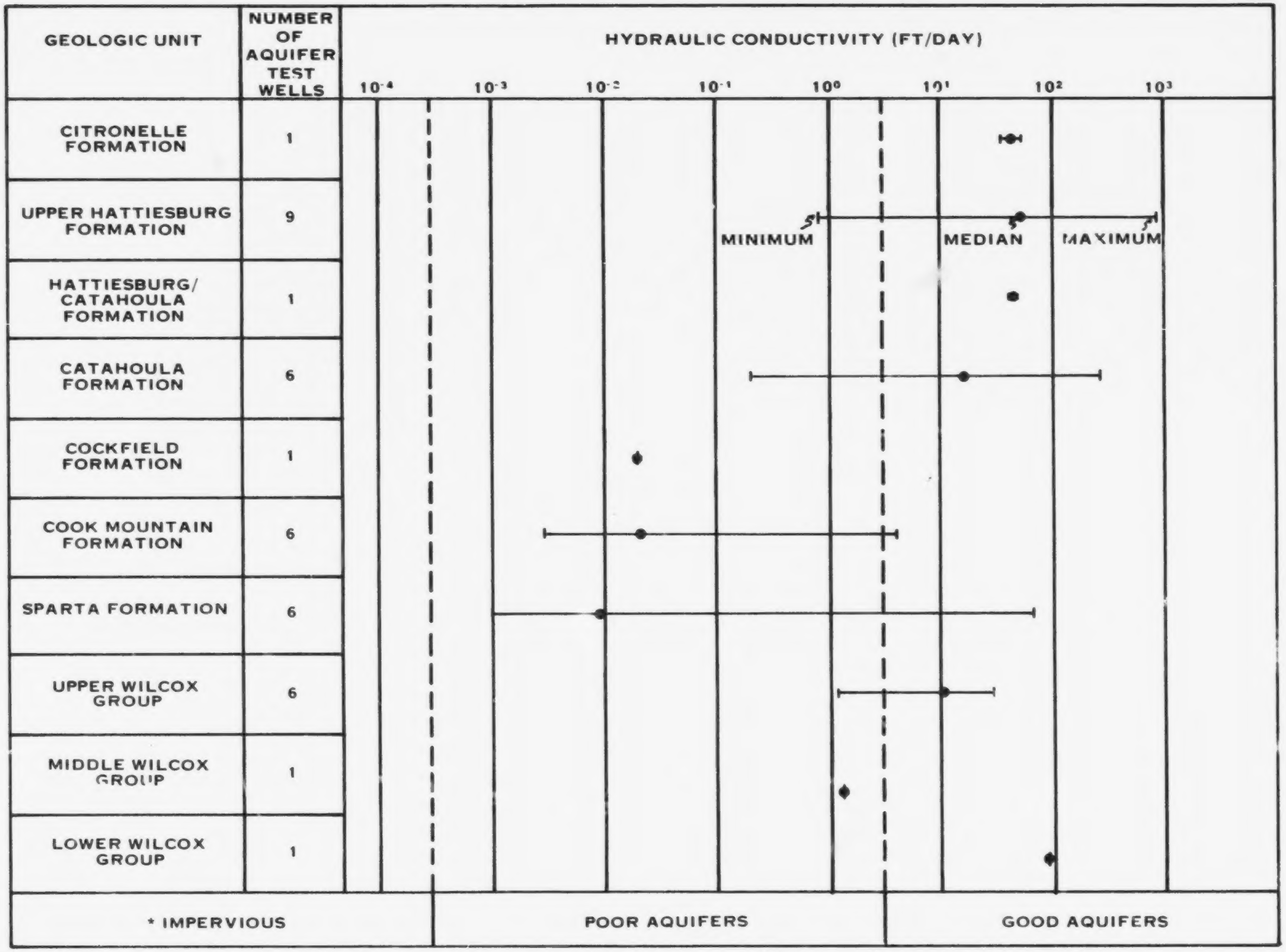
JOB NO. MV9600

FIGURE 14-6

BEST DOCUMENT AVAILABLE

TABLE 14-2

AQUIFER TEST SUMMARY FOR SELECTED GEOLOGIC UNITS



GEOLOGIC UNIT	NUMBER OF AQUIFER TEST WELLS
CITRONELLE FORMATION	1
UPPER HATTIESBURG FORMATION	9
HATTIESBURG/ CATAHOULA FORMATION	1
CATAHOULA FORMATION	6
COCKFIELD FORMATION	1
COOK MOUNTAIN FORMATION	6
SPARTA FORMATION	6
UPPER WILCOX GROUP	6
MIDDLE WILCOX GROUP	1
LOWER WILCOX GROUP	1

* ADAPTED BY F.L. HOTES, FROM FAIR & GEYER, FIG. 9-4, PG. 221 "WATER SUPPLY & WASTE DISPOSAL" WILEY, 1956

BEST DOCUMENT AVAILABLE

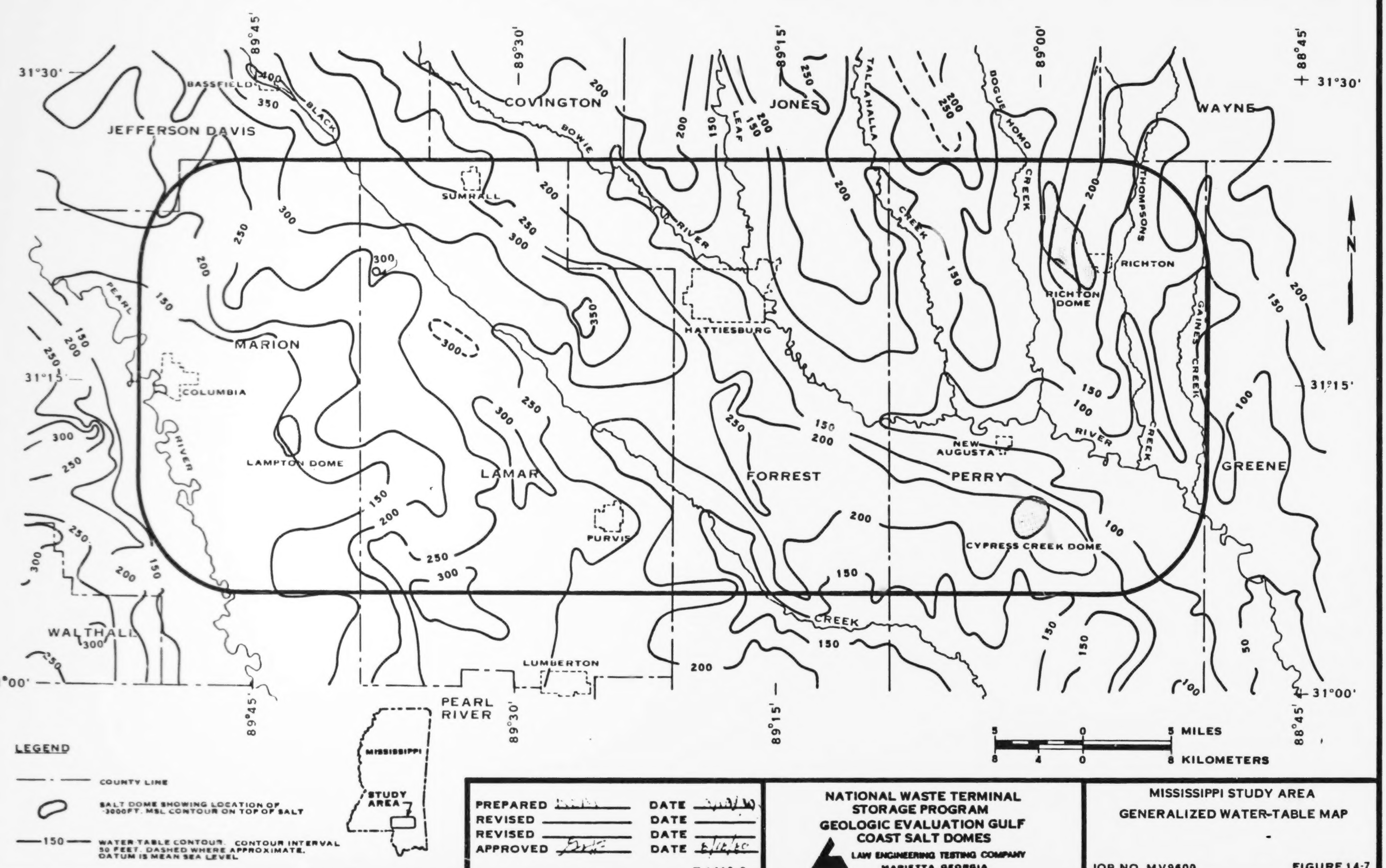
regional hydraulic conductivity for sand beds in both the Cook Mountain and Sparta Formations was estimated as 0.005 m/day (0.016 ft/day), based on the results of seven aquifer tests in the Cook Mountain Formation and six in the Sparta Formation. Test results for the Cook Mountain Formation varied between 0.0006 and 2 m/day (0.002 and 7 ft/day), while those for the Sparta Formation varied between 0.003 and 20 m/day (0.01 and 67 ft/day).

One aquifer test was performed in the Citronelle Formation. Results of this test are in agreement with the regional definition of this formation as an aquifer (Table 14-2).

One aquifer test was also performed in the Cockfield Formation. Results of this test indicate that locally this formation has poor water-transmitting properties (Table 14-2).

14.2.2.2 Water Levels and Movement: Flow directions at shallow depths in the aquifer system (generally less than about 30 meters (100 ft)) were determined from the shape of the water table (Figure 14-7). Water-table contours were drawn using altitudes of streams and lakes, and water levels in wells. Water-level data for wells were supplied by USGS. Ground water flows at approximately right angles to these contours from areas of higher head to areas of lower head. The locations of the wells used to prepare this map are found in Figure 14-12. These data were supplemented from multiple wells at the 11 drill sites.

The water table is a subdued replica of the topography. In general, the local topographic high areas are local ground-water recharge areas, a recharge area being defined as an area where


31°30'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
JEFFERSON DAVIS
BASSFIELD
BLACK
COVINGTON
BOWIE
SUMRALL
JONES
LEAF
TALLAHALLA
BOGUE HOMO
WAYNE
CREEK
THOMPSONS
RICHTON
RICHTON DOME
GAINES CREEK
PEARL
RIVER
MARION
COLUMBIA
LAMPTON DOME
LAMAR
PURVIS
HATTIESBURG
FORREST
NEW AUGUSTA
PERRY
GREENE
CYPRESS CREEK DOME
WALTHALL
LUMBERTON
PEARL RIVER
MISSISSIPPI
STUDY AREA
50
100
150
200
250
300
350
400
N
5 0 5 MILES
8 4 0 8 KILOMETERS
LEGEND
COUNTY LINE
SALT DOME SHOWING LOCATION OF -3000FT. MSL CONTOUR ON TOP OF SALT
—150— WATER-TABLE CONTOUR. CONTOUR INTERVAL 50 FEET. DASHED WHERE APPROXIMATE. DATUM IS MEAN SEA LEVEL

PREPARED ______ DATE ______
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE ______
T-1418-0

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
GENERALIZED WATER-TABLE MAP

JOB NO. MV9600
FIGURE 14-7

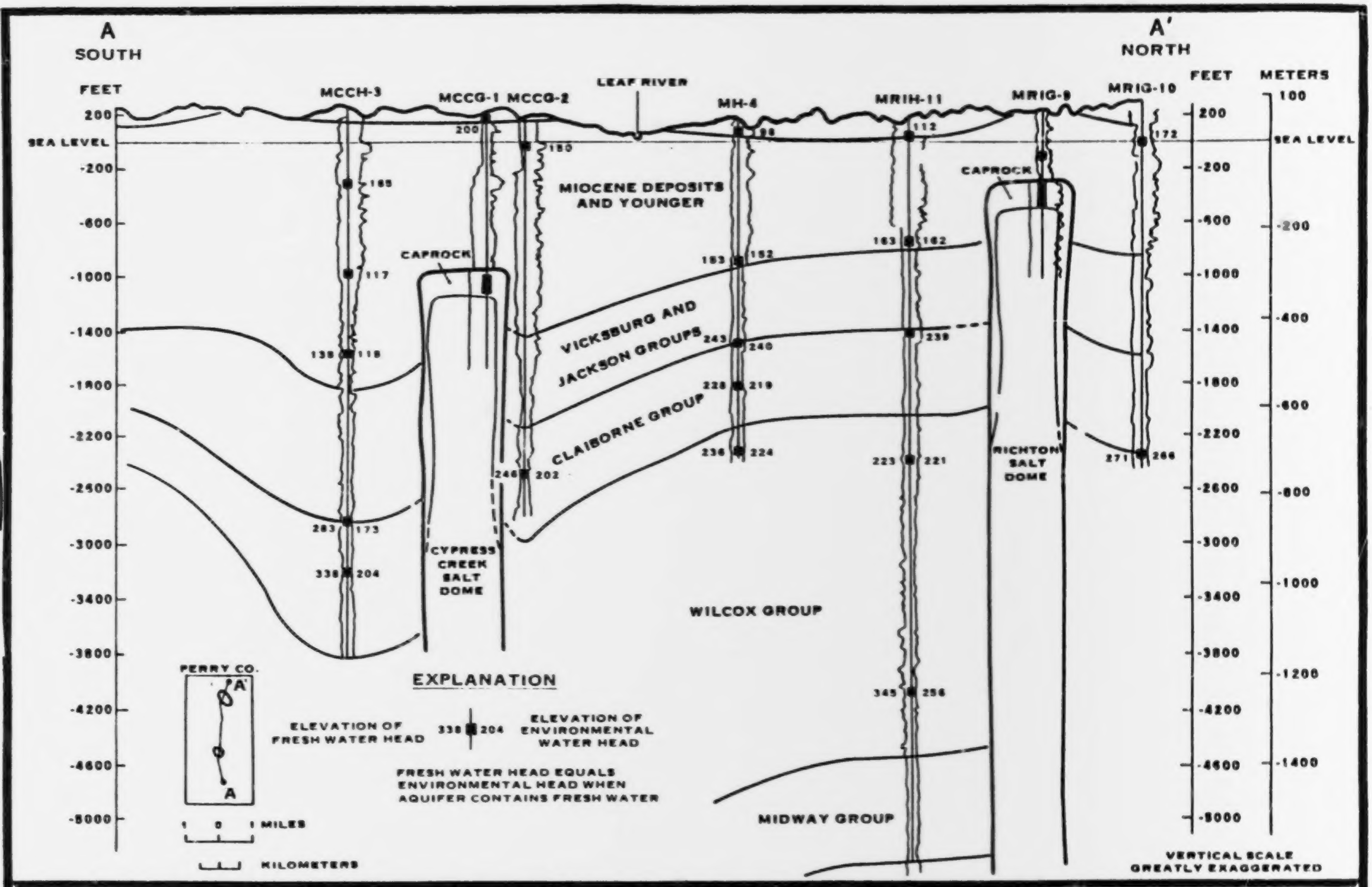
BEST DOCUMENT AVAILABLE

the vertical component of ground-water flow is downward. The Pearl and Leaf River Valleys and the Black Creek Valley are topographically low areas. These valleys are local ground-water discharge areas, or areas where the vertical component of ground-water flow is upward.

Flow directions at greater depths in the aquifer system were determined from environmental- and fresh-water heads shown on cross section A-A' (Figure 14-8). Fresh-water and environmental-water heads, shown in Figure 14-8, were used to estimate average flow rates, both horizontally and vertically, between Richton and Cypress Creek Domes. In the fresh-water aquifers (Miocene and younger) at the -183-meter (-600-ft)-elevation, horizontal flow potentials show ground water is moving southward from Richton to Cypress Creek Dome. In the deeper, more saline aquifer, decreasing head does not occur along a horizontal plane from north to south, but tends to have an upward component. This indicates the potential for deeper saline water to move across formations of the Vicksburg, Jackson, and Claiborne Groups between the two domes.

Heads in the Cook Mountain Formation near Lampton Dome have been altered by brine disposal. Disposal wells are located in the Baxterville, Sandy Hook, and Hub Oil Fields. Wells in these fields inject brine under pressure. This increasing pressure cone has caused potentiometric gradients in the Cook Mountain Formation to shift from a southerly direction to a northeasterly direction.

BEST DOCUMENT AVAILABLE


A
SOUTH
A'
NORTH
FEET
200
SEA LEVEL
-200
-600
-1000
-1400
-1800
-2200
-2500
-3000
-3400
-3800
-4200
-4600
-5000
METERS
100
-200
-400
-600
-800
-1000
-1200
-1400
MCCH-3
MCCG-1
MCCG-2
LEAF RIVER
MH-4
MRIH-11
MRIG-9
MRIG-10
200
150
98
112
172
165
117
139
118
283
173
338
204
246
202
153
152
243
240
228
219
236
224
163
162
239
223
221
345
256
271
266
CAPROCK
CYPRESS CREEK SALT DOME
MIOCENE DEPOSITS AND YOUNGER
VICKSBURG AND JACKSON GROUPS
CLAIBORNE GROUP
WILCOX GROUP
MIDWAY GROUP
RICHTON SALT DOME
PERRY CO.
1 0 1 MILES
KILOMETERS
EXPLANATION
ELEVATION OF FRESH WATER HEAD
338 204
ELEVATION OF ENVIRONMENTAL WATER HEAD
FRESH WATER HEAD EQUALS ENVIRONMENTAL HEAD WHEN AQUIFER CONTAINS FRESH WATER
VERTICAL SCALE GREATLY EXAGGERATED

PREPARED		DATE	
REVISED		DATE	
REVISED		DATE	
APPROVED		DATE	

T-2103-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM

GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
FRESH-WATER AND ENVIRONMENTAL WATER HEADS ALONG GENERALIZED CROSS SECTION A-A' THROUGH RICHTON AND CYPRESS CREEK DOMES

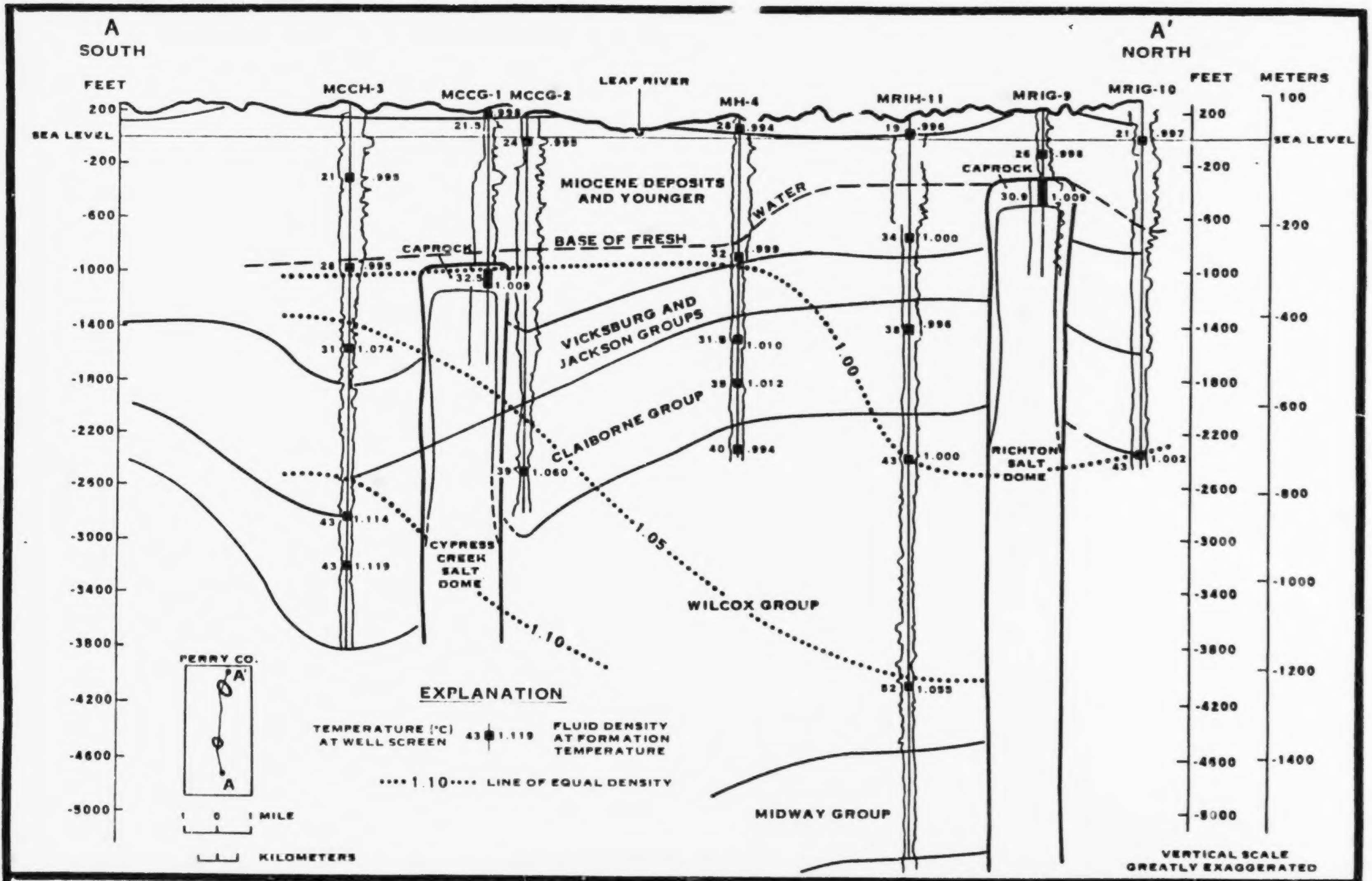
JOB NO. MV9600

FIGURE 14-8

Vertical flow directions below the upper 30 to 61 meters (100 to 200 ft) of the aquifer system were determined from an analysis of the vertical distribution of environmental heads in the aquifer system (Figure 14-8). Environmental heads show the altitude to which formation fluid, adjusted to the variable density occurring in the aquifer above the sampling point, would rise in wells (Lusczynski, 1961). Figure 14-9 presents the distribution of temperature and density along Cross Section A-A' used to calculate environmental heads. There appears to be a regional trend toward increasing head with increasing depth in the saline-water zone, indicating that upward flow may be occurring from the saline-water zone to the fresh-water zone between the two domes. This flow analysis is supported by the density lines shown in Figure 14-9. These lines cross at right angles to the bedding, which is contrary to density distributions elsewhere in the salt dome basin. Elsewhere, densities are stratified, much like the bedding, and they usually parallel the bedding. In this case, density lines, which cross the bedding, indicate ground-water flow paths that have a horizontal and vertical component. Decreasing head potentials occur along these density lines from north to south, which further indicates that flow parallels density distributions.

Average ground-water velocities at the various depths were estimated on the basis of the hydraulic gradients, effective porosity, and hydraulic conductivity estimates for geologic formations. Ground-water velocities in the Catahoula Formation at -244 meters (-800 ft) MSL, and in the Wilcox Group at -914

BEST DOCUMENT AVAILABLE


A
SOUTH
A'
NORTH
FEET
200
SEA LEVEL
-200
-600
-1000
-1400
-1800
-2200
-2600
-3000
-3400
-3800
-4200
-4600
-5000
METERS
100
-200
-400
-600
-800
-1000
-1200
-1400
MCCH-3
MCCG-1
MCCG-2
LEAF RIVER
MH-4
MRIH-11
MRIG-9
MRIG-10
MIOCENE DEPOSITS AND YOUNGER
BASE OF FRESH WATER
CAPROCK
VICKSBURG AND JACKSON GROUPS
CLAIBORNE GROUP
WILCOX GROUP
MIDWAY GROUP
CYPRESS CREEK SALT DOME
RICHTON SALT DOME
1.00
1.05
1.10
21 .995
26 .995
31 1.074
43 1.114
43 1.119
21.5 .998
24 .995
32.5 1.009
39 1.060
28 .994
32 .999
31.8 1.010
38 1.012
40 .994
19 .996
34 1.000
38 .996
43 1.000
52 1.055
26 .998
30.9 1.009
21 .997
43 1.002
PERRY CO.
A'
A
1 0 1 MILE
KILOMETERS
EXPLANATION
TEMPERATURE (°C) AT WELL SCREEN
43 1.119
FLUID DENSITY AT FORMATION TEMPERATURE
1.10 LINE OF EQUAL DENSITY
VERTICAL SCALE GREATLY EXAGGERATED

PREPARED CAS DATE ______
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE ______

T-2104-0

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
TEMPERATURE AND DENSITY DISTRIBUTION ALONG GENERALIZED CROSS SECTION A-A' THROUGH RICHTON AND CYPRESS CREEK DOMES

JOB NO. 1V9600 FIGURE 14-9

meters (-3,000 ft) MSL, average about 5 and 3 m/yr (16 and 9 ft/yr), respectively. Ground-water velocities at -701 meters (-2,300 ft) MSL are variable, ranging from less than 0.3 m/yr (1 ft/yr) in the Claiborne Group in the west, to about 5 m/yr (15 ft/yr) in the Upper Wilcox Group in the east.

Published data indicate that water movement in the Hattiesburg and Catahoula Formations is generally downdip, following the regional trend of the sediments in the area (Taylor and others, 1968). Flow velocities computed by Taylor ranged from 0.3 to 49 m/yr (1 to 160 ft/yr). These data are in agreement with estimated water movement in the Hattiesburg and Catahoula Formations in the study area.

Increasing population in southern Mississippi during the period 1964 to 1966 was reflected in a slowly declining water level in the Miocene deposits at a rate of about 0.3 m/yr (1 ft/yr) (Shows and others, 1966). Locally, heavy pumping near the town of Hattiesburg has led to greater water-level declines in this area.

14.2.3 WATER CHEMISTRY: The chemistry of surface and ground water was investigated regionally. Data for analyses of surface-water chemistry were sparse, while data for analyses of ground-water chemistry provided fair coverage of the study area. The USGS has collected surface-water chemistry information at several locations in and around the study area (Figure 14-2). In the Pascagoula River basin, data have been collected on Cypress Creek near Janice, Tallahala Creek near Sandersville, and Pascagoula

River near Benndale. In the Pearl River basin, data have been collected on the Pearl River near Monticello.

Surface water within the Pearl and Pascagoula River basins is generally a dilute calcium bicarbonate or sodium bicarbonate type water (the principal ions in solution are calcium or sodium and bicarbonate) (Shows and others, 1966; Gandl and Spiers, 1980). Total dissolved-solids concentration in the water is generally less than 200 mg/l (200 ppm), although exceptions are common. The pH of the water is generally less than 7.0 standard units.

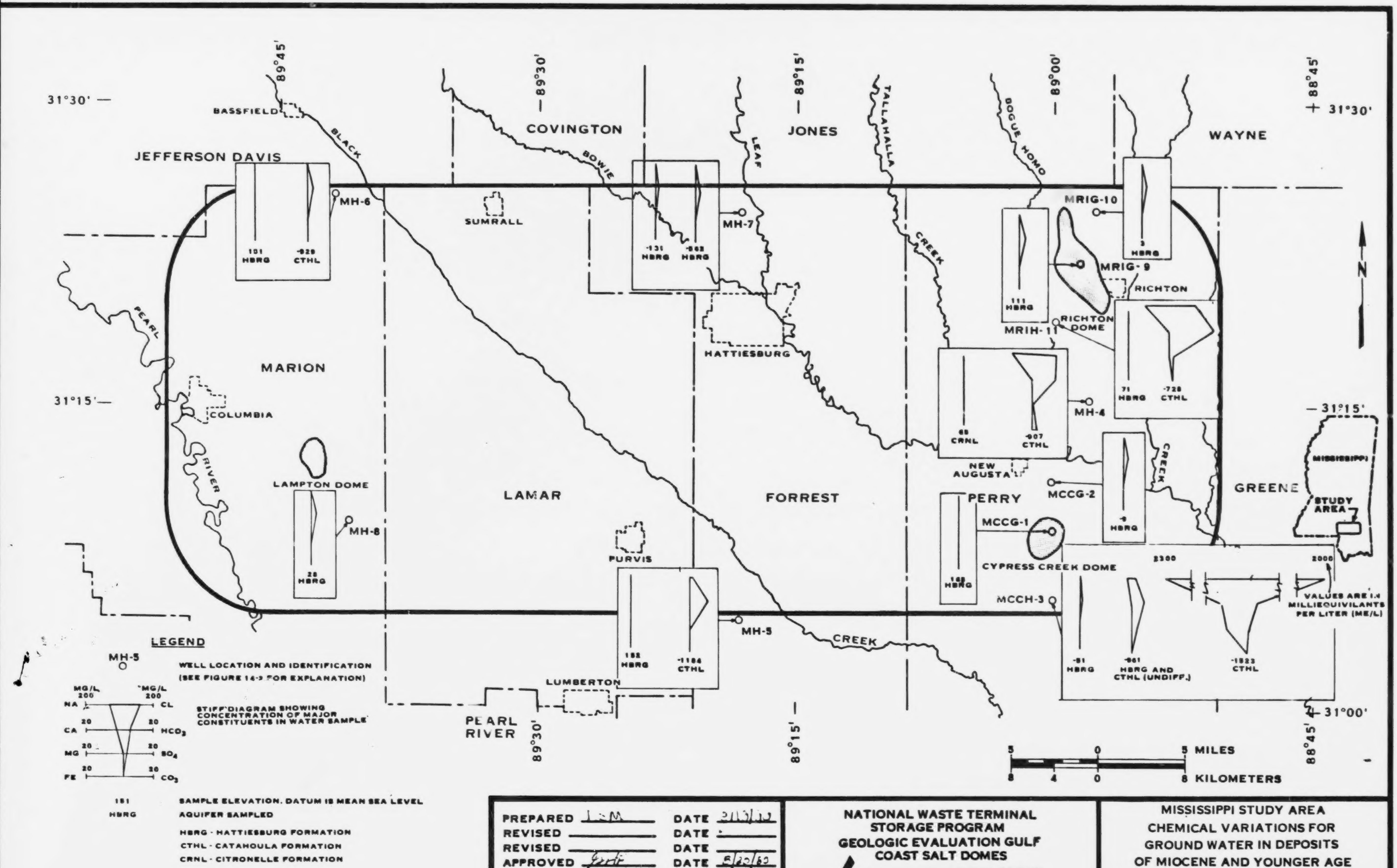
Short-term variations in surface-water chemistry are common and generally occur during low flow periods. During these times much of the stream flow may be from effluent discharge and ground-water discharge. Shows and others (1966) report monitoring brine pollution in the Leaf River during the 1965 water year.

Ground-water chemistry data for samples from 173 wells in and around the study area have been studied. These data consist of chemical analyses on file with the USGS and analyses made on ground-water samples collected as part of this project.

Most ground waters in deposits of Quaternary age are a calcium bicarbonate type, as evidenced by published analyses of surface waters (Shows and others, 1966). The composition of these waters is derived in part from contact with surficial deposits. These waters generally have the shortest contact time with the surrounding geologic environment and they are therefore least mineralized.

The chemical composition of ground water in the upper beds of Miocene deposits are generally similar throughout the study area

[redacted]


31°30'
89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
BASSFIELD
COVINGTON
JONES
WAYNE
JEFFERSON DAVIS
BLACK
BOWIE
LEAF
TALLAHALLA
BOGUE HOMO
MH-6
101 HBRG
-929 CTHL
SUMRALL
MH-7
-131 HBRG
-563 HBRG
CREEK
MRIG-10
3 HBRG
MRIG-9
RICHTON
111 HBRG
RICHTON DOME
MRIH-11
HATTIESBURG
N
PEARL
MARION
71 HBRG
-728 CTHL
MH-4
65 CRNL
-907 CTHL
31°15'
COLUMBIA
31°15'
MISSISSIPPI
RIVER
LAMPTON DOME
LAMAR
FORREST
NEW AUGUSTA
PERRY
MCCG-2
-9 HBRG
GREENE
STUDY AREA
MH-8
28 HBRG
MCCG-1
165 HBRG
CYPRESS CREEK DOME
PURVIS
2300
2000
MCCH-3
VALUES ARE IN MILLIEQUIVILANTS PER LITER (ME/L)
MH-5
152 HBRG
-1184 CTHL
CREEK
-51 HBRG
-961 HBRG AND CTHL (UNDIFF.)
-1523 CTHL
LUMBERTON
31°00'
PEARL RIVER
89°30'
89°15'
88°45'
5 0 5 MILES
8 4 0 8 KILOMETERS
LEGEND
MH-5
WELL LOCATION AND IDENTIFICATION (SEE FIGURE 14-3 FOR EXPLANATION)
MG/L 200
MG/L 200
NA
CL
20
CA
20
HCO3
20
MG
20
SO4
20
FE
20
CO3
STIFF DIAGRAM SHOWING CONCENTRATION OF MAJOR CONSTITUENTS IN WATER SAMPLE
151
SAMPLE ELEVATION. DATUM IS MEAN SEA LEVEL
HBRG
AQUIFER SAMPLED
HBRG - HATTIESBURG FORMATION
CTHL - CATAHOULA FORMATION
CRNL - CITRONELLE FORMATION

PREPARED	LSM	DATE	2/13/79
REVISED		DATE	
REVISED		DATE	
APPROVED	JWF	DATE	8/20/80

T-1447-1

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
CHEMICAL VARIATIONS FOR
GROUND WATER IN DEPOSITS
OF MIOCENE AND YOUNGER AGE

JOB NO. MV9600

FIGURE 14-10

BEST DOCUMENT AVAILABLE

TABLE 14-3
SUMMARY OF WATER CHEMISTRY CHARACTERISTICS IN THE FRESH WATER AQUIFER SYSTEM
(ALL VALUES REPORTED IN MILLIGRAMS PER LITER)

Statistic*	Sodium dissolved (as Na)	Chloride dissolved (as Cl)	Bicarbonate dissolved (as HCO_3)	Calcium dissolved (as Ca)	Magnesium dissolved (as Mg)	Sulfate dissolved (as SO_4)	Iron, Total Recoverable (as Fe)	Silica dissolved (as SiO_2)	Potassium dissolved (as K)	Dissolved Solids (Residue at 180°C)	Hardness (as $CaCO_3$)	pH (s.u.)
Median	24	6	79	3.4	1.0	6.6	.210	20	1.9	126	13	6.9
Mean	425	550	100	6.2	2.5	22	.774	25	3.5	1136	27	6.9
Range	1.6-54,000	0.4-73,000	2-1580	0-200	0-150	0-2300	0-8.9	0-64	0-160	22-130,000	0-1300	5.2-9.1

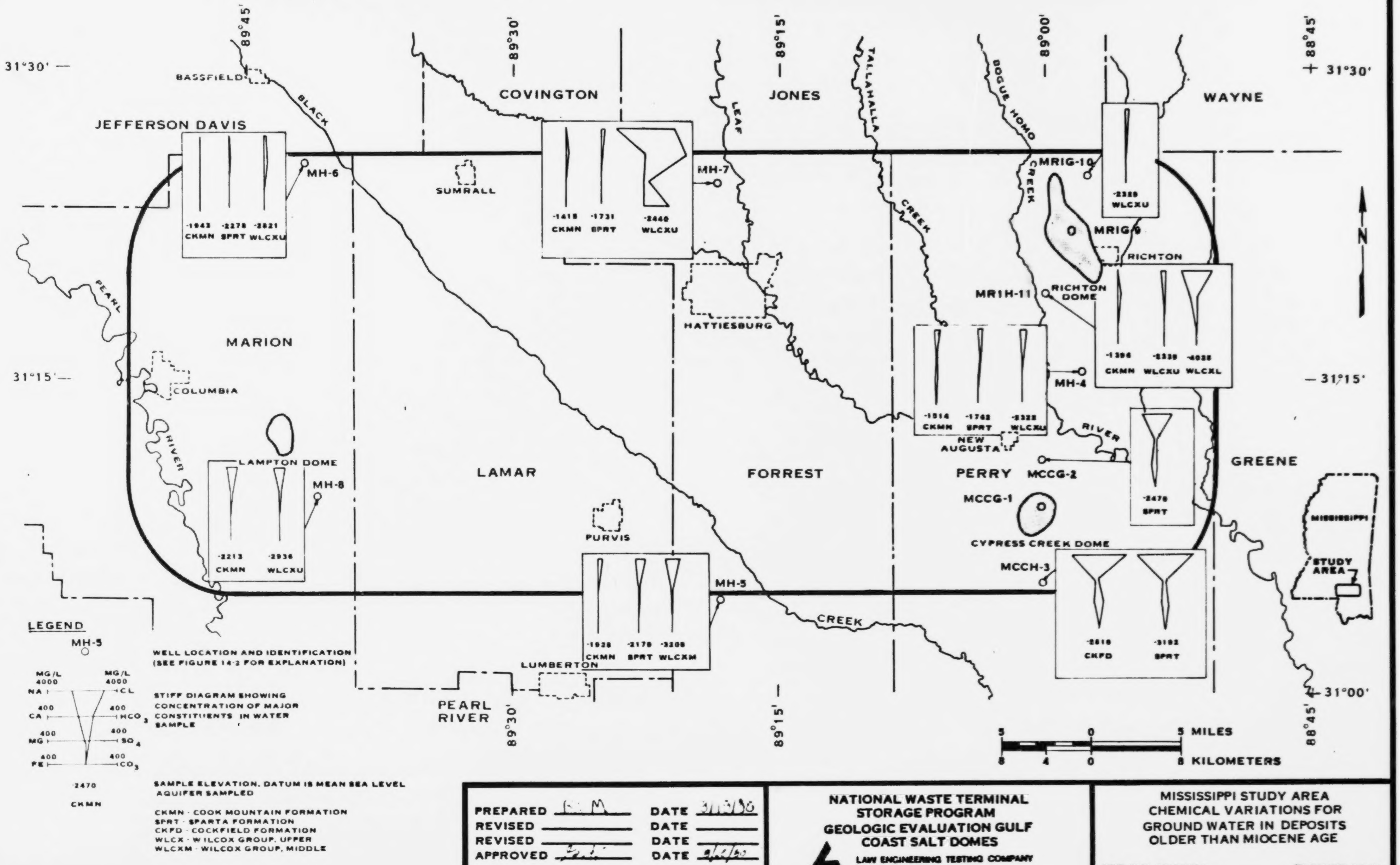
*Based on 148 analyses from USGS files.

(Figure 14-10 and Table 14-3). Ground waters in these deposits are mostly a dilute sodium bicarbonate type, low in total dissolved solids and high in iron. Median values for sodium, bicarbonate, and total dissolved-solids are 31, 79, and 120 mg/l (31, 79, and 120 ppm) respectively. The predominance of bicarbonate with respect to other dissolved ions indicates some flushing action by meteoric water or shallow ground water (Parker, 1967; Freeze and Cherry, 1979). The relative abundance of sodium indicates movement through well-leached sediments, which in turn indicates continual flushing of the aquifer.

The above observations suggest that there is a change from calcium bicarbonate to sodium bicarbonate water at shallow depths in the fresh-water zone. This tendency has been reported by many investigators in other study areas (Back and Hanshaw, 1965; Back, 1966, Shows and others, 1966; Taylor and others, 1968; Keady, 1970; Kreitler, 1980, written communication). The controlling process is attributed to exchange of sodium by calcium on clays and other materials providing exchange sites.

The total dissolved-solids content in ground water increases with depth in the aquifer system. Increases in sodium, chloride, and bicarbonate account for most of the increase with depth in the total dissolved-solids content of the water. The varying chemical composition of the water with depth is illustrated in Figures 14-10 and 14-11.

Waters from deposits underlying the fresh-water zone may be characterized as sodium chloride types of varying concentrations. Concentrations of sodium, calcium, magnesium and potassium


31°30'
89°45'
89°30'
89°15'
89°00'
88°45'
31°30'
BASSFIELD
COVINGTON
JONES
WAYNE
JEFFERSON DAVIS
BLACK
LEAF
TALLAHALLA
BOGUE HOMO
CREEK
MH-6
-1943 CKMN
-2278 SPRT
-2821 WLCXU
SUMRALL
-1418 CKMN
-1731 SPRT
-2440 WLCXU
MH-7
MRIG-10
-2329 WLCXU
MRIG-9
N
RICHTON
MR1H-11
RICHTON DOME
-1396 CKMN
-2339 WLCXU
-4028 WLCXL
HATTIESBURG
PEARL
MARION
31°15'
COLUMBIA
RIVER
-1514 CKMN
-1762 SPRT
-2322 WLCXU
MH-4
31°15'
NEW AUGUSTA
RIVER
LAMPTON DOME
MH-8
-2213 CKMN
-2936 WLCXU
LAMAR
FORREST
PERRY
MCCG-2
GREENE
MCCG-1
-2476 SPRT
CYPRESS CREEK DOME
MISSISSIPPI
STUDY AREA
PURVIS
MH-5
MCCH-3
-1928 CKMN
-2179 SPRT
-3208 WLCXM
CREEK
-2616 CKFD
-3182 SPRT
LUMBERTON
31°00'
PEARL RIVER
89°30'
89°15'
88°45'
5 0 5 MILES
8 4 0 8 KILOMETERS
LEGEND
MH-5
WELL LOCATION AND IDENTIFICATION (SEE FIGURE 14-2 FOR EXPLANATION)
MG/L 4000
MG/L 4000
NA
CL
400
CA
400
HCO3
400
MG
400
SO4
400
FE
400
CO3
STIFF DIAGRAM SHOWING CONCENTRATION OF MAJOR CONSTITUENTS IN WATER SAMPLE
-2470
CKMN
SAMPLE ELEVATION, DATUM IS MEAN SEA LEVEL
AQUIFER SAMPLED
CKMN - COOK MOUNTAIN FORMATION
SPRT - SPARTA FORMATION
CKFD - COCKFIELD FORMATION
WLCX - WILCOX GROUP, UPPER
WLCXM - WILCOX GROUP, MIDDLE

PREPARED R. M.	DATE 3/13/80
REVISED	DATE
REVISED	DATE
APPROVED	DATE 9/2/80

T-1448-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA CHEMICAL VARIATIONS FOR GROUND WATER IN DEPOSITS OLDER THAN MIOCENE AGE

JOB NO. MV9600

FIGURE 14-11

BEST DOCUMENT AVAILABLE

increase with depth. Bicarbonate concentration also increases with depth but at a slower rate. These changes could be accounted for by increased leaching at depth resulting from the slower flow of water through the geologic environment combined with exchange of calcium for sodium between sediments and water. It could also indicate less flushing of formation waters. Further investigation is needed to determine the relationship between dissolved consitutents and depth.

Although calcium, magnesium, and potassium increase with depth, their ratios to chloride concentraion decrease with depth. This relationship indicates chloride is being concentrated in deeper waters at a faster rate than calcium, magnesium, or potassium. This is to be expected because chloride generally does not enter into reactions which remove it from solution.

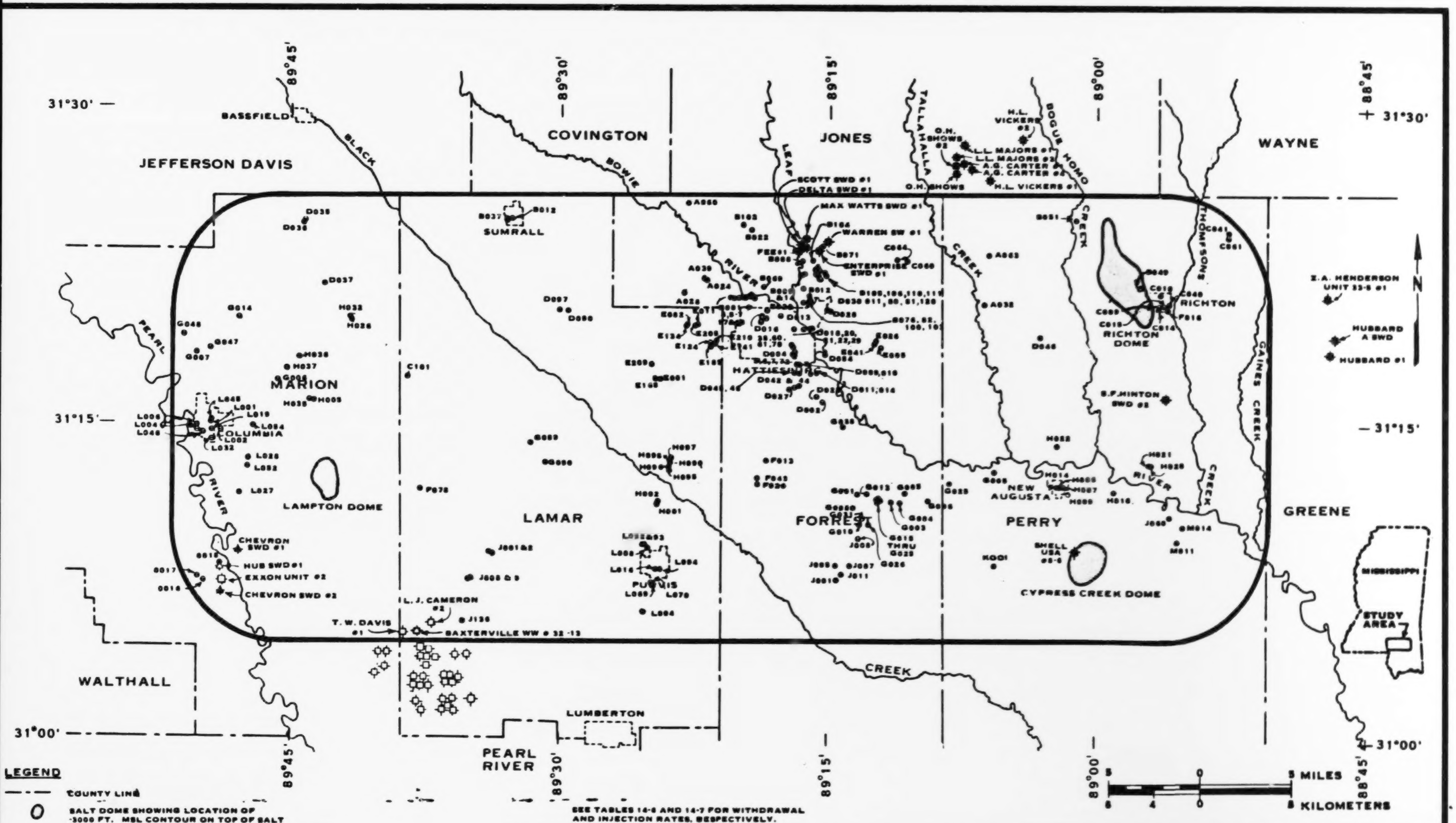
The chemical composition of ground waters in the saline-water zone are generally similar in the study area (Figure 14-11). One exception occurs at Site MH-7. Brine from nearby disposal wells may account for this observed anomaly. The locations of nearby brine disposal wells are shown in Figure 14-12.

Samples for gas content analyses were obtained at Sites MH-4, MH-8, and MH-11 from the Cook Mountain Formation; at Sites MH-4, MH-7, and MRIH-11 from the Wilcox Group; and at Site MH-7 from the Sparta Formation. Methane, ethane, and hydrogen were detected in most samples. In samples obtained from the Cook Mountain Formation, methane content exceeded 130,000 mg/l (130,000 ppm) and was as high as 275,000 mg/l (275,000 ppm) at Site MH-8. Methane content in samples from the Wilcox Group exceeded 200,00 mg/l (200,000 ppm), and it was as high as 280,000 mg/l (280,000 ppm) at MRIH-11. In the one sample from the Sparta Formation (MH-7) 20,000 mg/l (20,000 ppm) of methane was detected. Hydrogen content ranged from 1 to 130,000 mg/l (1 to 130,000 ppm), and ethane ranged from zero to 40,000 mg/l (40,000 ppm).

Salt domes are warmer than the surrounding sediments at comparable depths below land surface (Law Engineering Testing Company, 1980). This phenomenon occurs because salt can conduct heat upward from deeper depths more effectively than the surrounding sediments.

The higher thermal conductivity of salt domes also causes them to have a lower thermal gradient than the adjacent sediments. Temperature data from 78 wells in the vicinity of Lampton and Richton Domes indicate a geothermal gradient of -17 C (1.1 F) per 30 meters (100 ft) for Lampton and Richton Domes, and -17 C (1.4 F) per 30 meters (100 ft) for sediments near the domes. The average geothermal gradient for the sediments in the Mississippi Study Basin is also -17 C (1.4 F) per 30 meters (100 ft).

14.2.4 RELATIONSHIP OF SURFACE WATER TO GROUND WATER: Low flow of streams is the sustained, normal dry-weather discharge a stream can maintain; it consists largely of ground-water discharge. A quantitative measure of low flow at a point on a stream is the 7-day, 2-year low flow ($7Q_2$). This value represents the lowest mean discharge for seven consecutive days, occurring on the average of once in 2 years at the measuring point. Values of the 7-day, 2-year low flow have been determined


31°30'
89°45'
89°30'
89°15'
89°00'
88°45'
31°15'
31°00'
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
BASSFIELD
SUMRALL
HATTIESBURG
COLUMBIA
PURVIS
LUMBERTON
NEW AUGUSTA
RICHTON
LAMPTON DOME
RICHTON DOME
CYPRESS CREEK DOME
PEARL RIVER
BLACK CREEK
BOWIE RIVER
LEAF RIVER
TALLAHALLA CREEK
BOGUE HOMO CREEK
THOMPSONS CREEK
GAINES CREEK
SCOTT SWD #1
DELTA SWD #1
MAX WATTS SWD #1
WARREN SW #1
ENTERPRISE SWD #1
H.L. VICKERS #2
O.H. SHOWS #2
L.L. MAJORS #1
L.L. MAJORS #2
A.G. CARTER #1
A.G. CARTER #2
O.H. SHOWS
H.L. VICKERS #1
Z.A. HENDERSON UNIT 33-5 #1
HUBBARD A SWD
HUBBARD #1
S.F. HINTON SWD #2
SHELL USA #5-6
CHEVRON SWD #1
HUB SWD #1
EXXON UNIT #2
CHEVRON SWD #2
L.J. CAMERON #2
T.W. DAVIS #1
BAXTERVILLE WW # 32-13
N
MISSISSIPPI
STUDY AREA
5 0 5 MILES
8 4 0 8 KILOMETERS

SEE TABLES 14-6 AND 14-7 FOR WITHDRAWAL AND INJECTION RATES, RESPECTIVELY.

LEGEND

- — - — COUNTY LINE
- O SALT DOME SHOWING LOCATION OF -3000 FT. MSL CONTOUR ON TOP OF SALT
- ● SELECTED HIGH-CAPACITY WATER-SUPPLY WELLS.
- ✦ WASTE DISPOSAL WELL COMPLETED IN SPARTA FORMATION
- ✧ WASTE DISPOSAL WELL COMPLETED IN UNDIFFERENTIATED CLAIBORNE GROUP.
- ✹ WASTE DISPOSAL WELL COMPLETED IN WILCOX GROUP
- ⌖ WASTE DISPOSAL WELL COMPLETED IN COOK MOUNTAIN FORMATION

PREPARED RSM DATE 2/18/80
REVISED DATE
REVISED DATE
APPROVED DATE 2/20/80
T-1417-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

LOCATION OF WASTE DISPOSAL WELLS AND SELECTED HIGH CAPACITY WATER SUPPLY WELLS

JOB NO. MV9600 FIGURE 14-12

BEST DOCUMENT AVAILABLE

for points along streams in the study area (Shows and others, 1966; Taylor and others, 1968).

The 7-day, 2-year low flow of streams generally decreases to the east and north across the study area. Flows greater than approximately 11.3 l/sec (0.4 ft^3/sec) per square mile of drainage area can be expected in many areas of the Pearl River Basin in Marion County. Flows of approximately 5.6 l/sec (0.2 ft^3/sec) per square mile occur in the Black Creek Basin in southern Lamar County. Flows less than 5.6 l/sec (0.2 ft^3/sec) per square mile generally can be expected in Forrest and Perry Counties, and flows less than 1.4 l/sec (0.05 ft^3/sec) per square mile commonly occur in northern Perry County. The one exception to the general trend is Bowie Creek in northern Forrest County, where low flows are approximately 14.1 l/sec (0.5 ft^3/sec) per square mile.

Differences in low flows reflect differences in the volume of ground-water storage and permeability of surficial deposits. Ground-water discharge is greatest in areas of permeable sand and gravel deposits of the Citronelle Formation in the western portion of the study area. Recharge is high, surface runoff is low, and ground-water storage is large in these areas. Ground-water discharge is less in other areas where the relatively less permeable Hattiesburg Formation is the dominant surficial unit.

14.2.5 WATER AND AQUIFER USE: Marion, Lamar, Forrest, and Perry Counties are all withdrawal areas for ground and surface water for a variety of industrial, agricultural, and municipal uses.

The heaviest use of water in the study area occurs around Hattiesburg, the largest city in Forrest County. A summary of water use by county is listed in Table 14-4.

Surface water of suitable chemical quality is available for most uses in the Mississippi Study Area. Most of the water utilized from surface sources is principally for industrial supplies in the paper, petroleum and electrical power industries. The largest withdrawal of surface water (115 million gallons per day) is from tributaries of the Pascagoula River near Hattiesburg. This water is used for cooling needed in the generation of electric power. A minor amount of surface water is also utilized for fish farming and livestock, with heaviest demand for these uses centered in Marion County (Callahan, 1975).

Ground water is extensively utilized in the four-county study area. Municipal and industrial uses account for the largest withdrawals of ground water, with heaviest demand centered in the Hattiesburg area. The location of selected high capacity water supply wells is shown on Figure 14-12. Table 14-5 summarizes well construction characteristics and average discharge rates for these wells.

Deposits of Miocene age and younger are the principal source of ground-water supplies. The Hattiesburg and Catahoula Formations are the formations most commonly tapped in Marion and Perry Counties. Forrest County wells generally tap the Catahoula Formation, whereas the Citronelle Formation is the principal source of water supply in Lamar County (Callahan, 1975).

TABLE 14-4

SUMMARY OF WATER USE

(MILLION GALLONS PER DAY)

COUNTY	PUBLIC SUPPLY								RURAL SELF-SUPPLIED				INDUSTRIAL SELF SUPPLIED		FUEL ELECTRIC POWER		IRRIGATION		FISH-FARM		TOTAL	
	MUNICIPAL SYSTEMS					RURAL SYSTEMS[1]				DOM.	LIVESTOCK											
	POPULATION	DOMESTIC		INDUSTRIAL					POPULATION													
		GW[2]	SW[3]	GW	SW	POPULATION	DOM.	IND.		GW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW
FORREST	38450	6.737		.447		17515	1.606	.143	6310	.278	.116	.173	9.597	5.164	.300	115.2	.016		.595	.399	19.836	120.936
LAMAR	5800	.402		.039		9410	.566		895	.039	.072	.108	3.144				.038		.839	.560	5.139	0.668
MARION	7775	.764		.083		6085	.344	.014	8875	.339	.187	.281	.409				.022		2.253	.836	3.363	1.117
PERRY	3055	.244		.126		.015	.049		5410	.197	.059	.088	.189						.137	.091	1.023	0.179

REF. CALLAHAN, 1975

1. RURAL SYSTEMS INCLUDE ALL PRIVATE WATER COMPANIES, WATER ASSOCIATIONS, AND OTHER SOURCES FURNISHING WATER TO THE PUBLIC OUTSIDE THE CITIES, TOWNS, AND VILLAGES.
2. GROUND WATER
3. SURFACE WATER

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
USGS	D035	Marion	S08 T05N R17W	Carpenter Oil		508	3	Miocene Series	80	N
do	D036	do	NW S08 T05N R17W	Carpenter Oil and Gas		525	3	do	75	N
do	D037	do	SW S28 T05N R17W	Shell Oil Company		609	3	do	70	N
do	G006	do	NW NE S25 T04N R18W	Community	300	523	10	Lower Catahoula Formation	100	P
do	G007	do	NE SW S17 T04N R18W	Cedar Grove Water Authority	220	790	6	do	50	P
do	G014	do	NW SE S03 T04N R18W	Columbia Training School	230	420	10	Hattiesburg Formation	265	T
do	G047	do	SW NW S16 T04N R18W	Cedar Grove Water Authority	260	787	6	Miocene Series	150	P
do	G048	do	NW SE S07 T04N R18W	First Energy Corporation	220	378	3	Miocene Series	70	Z

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	H005	do	NW NE S32 T04N R17W	Highway 98 East Water Authority	248	960	6	Lower Catahoula Formation	150	P
do	H026	do	NW SE S03 T04N R17W	Mount Gilead - Impove	350	390	8	Hattiesburg Formation	200	P
do	H032	do	NW SE S03 T04N R17W	do	do	do	do	do	do	do
do	H035	do	NE NW S32 T04N R17W	Highway 98 East Water Authority	325	922	6	Miocene Series	167	do
do	H036	do	SE S18 T04N R17W	Sun Oil Company		509	3	do	80	N
do	H037	do	SW NW S19 T04N R17W	Sun Gas	310	504	3	do	70	Z
do	L001	do	SW NW S04 T03N R18W	Columbia	210	147	20		857	P
do	L002	do	SW SE S04 T03N R18W	do	do	140	do		1000	do

292

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	L004	do	SE SW S05 T03N R18W	Reichhold Chemical	do	540	6	Hattiesburg Formation	85	N
do	L006	do	do	Reason Chemical	do	500		do	240	do
do	L019	do	SW SW S04 T03N R18W	Columbia City	154	508	6	do	400	P
do	L027	do	SW NE S27 T03N R18W	Hub Water Authority	200	723	do	do	200	do
do	L028	do	SW NW S14 T03N R18W	Lampton Water Authority	195	195	12		300	do
do	L032	do	SW NW S09 T03N R18W	Columbia	210	103	24		700	do
do	L045	do	SW NW S04 T03N R18W	Columbia	152	142	12	Hattiesburg Formation	1000	do
do	L046	do	SE SW S05 T03N R18W	Reichhold Chemical	147	130	12		644	N

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	L052	do	SW SW S14 T03N R18W	Lampton Water Authority	195	192	10	Miocene Series	399	P
do	L054	do	NE SW S02 T03N R18W	Hunt Petroleum	240	342	3	do	70	Z
do	O016	do	S19 T02N R14E	Exxon Oil Company	125	126	4	do	100	do
do	O017	do	SW NW S19 T02N R14E	do	145	609	3	do	80	do
do	O018	do	NE SW S17 T02N R14E	do	121	636	4	do	150	do
do	B012	Lamar	NE NW S07 T05N R15W	Sumrall	270	358	10	do		P
do	B037	do	SE NW S07 T05N R15W	do	do	382	do	Hattiesburg Formation	250	do
do	C101	do	S19 T04N R16W	Sun Oil Company	285	546	3	Miocene Series	75	Z

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	D090	do	NW NE S03 T04N R15W	West Lamar Water Authority	440	431	10	do	500	P
do	D097	do	NW NW S03 T04N R15W	do	430	425	do	do	644	do
do	E001	do	SW SE S21 T04N R14W	North Lamar Water Authority	410	165	6	do	156	do
do	E011	do	SW SE S02 T04N R14W	Arnold Line	240	880	4	Hattiesburg Formation	75	Z
do	E082	do	SW SW S02 T04N R14W	Arnold Line Water Authority	do	786	8	Miocene Series	150	P
do	E124	do	SE SW S12 T04N R14W	Lamar Park Subdivision	280	721	6	do	do	do
do	E134	do	SW SW S02 T04N R14W	Arnold Line Water Authority	235	770	8	Lower Catahoula Formation	250	do
do	E141	do	SW SE S12 T04N R14W	Lamar Park Water Authority	280	714	10	do	315	do

TABLE 14-6

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	E169	do	SE SW S21 T04N R14W	North Lamar Water Authority	405	180	8	Miocene Series	200	do
do	E189	do	NE NW S13 T04N R14W	Lamar Park Water Authority	270	714	10	do	300	do
do	E205	do	SW SE S02 T04N R14W	Arnold Line Water Authority	235	802	do	do	412	do
do	E209	do	NW NW S21 T04N R14W	North Lamar Water Authority	398	187	6	do	203	do
do	E210	do	SW SE S12 T04N R14W	Lamar Park Water Authority	250	740	8	do	300	do
do	F078	do	SE SW S20 T03N R16W	System Fuels	do	441	3	do	70	N
do	G089	do	S08 T03N R15W	Sun Oil Company		777	3	do	75	do
do	G090	do	SE NW S16 T03N R15W	Exxon Corporation	366	780	do	do	do	do

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	G091	do	NW SE S05 T03N R15W	Sun Mineral	310	365	do	do	70	do
do	H001	do	NE SW S28 T03N R14W	Amerada Hess	340	911	10	do	800	do
do	H002	do	do	do	330	890	16	do	do	do
do	H003	do	NE SW S27 T03N R14W	do	350	904	do	do	do	do
do	H090	do	NW SW S15 T03N R14W	South Mississippi Electric Power	305	784	24	do	2000	do
do	H095	do	SW SW S15 T03N R14W	do	260	774	do	do	do	do
do	H096	do	NW SW S15 T03N R14W	do	280	773	do	do	do	do
do	H097	do	SW NW S15 T03N R14W	do	318	793	18	do	do	do

297

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	H098	do	do	do	290	771	do	do	do	do
do	J001	do	SE NW S12 T02N R16W	U. S. Atomic Energy Commission	306	782	16	do	75	
do	J002	do	do	do	do	1130	do	do	225	do
do	J008	do	SW SW S14 T02N R16W	do	295	820	do	do	91	do
do	J009	do	do	do	do	1000	9	do	182	do
do	J019	do	NE NE S14 T02N R16W	United States Atomic Energy Commission HT-6	266	783	8	do	100	
do	J136	do	SW NE S34 T02N R16W	Baxterville	416	200	8	Citronelle Formation	171	P
do	L004	do	NW SE S29 T02N R14W	Bass Memorial Academy	360	480	6	Miocene Series	200	T

BEST DOCUMENT AVAILABLE

298

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	L008	do	NE NE S08 T02N R14W	Town of Purvis	370	350	10		340	P
do	L016	do	NW S16 T02N R14W	Purvis	350	975	16	Hattiesburg Formation	757	do
do	L069	do	NW NW S21 T02N R14W	Lakeview Water Company	320	54	4	Citronelle Formation	18	P
do	L070	do	do	do	do	46	5	do	54	do
do	L092	do	SE SE S05 T02N R14W	Progress Water Authority	370	265	8	Miocene Series	205	do
do	L093	do	do	do	375	264	do	do	200	do
do	L094	do	SW NE S16 T02N R14W	Purvis	348	261	10	do	400	do
do	A024	Forrest	SW NW S25 T05N R14W	Rawls Springs Water Authority	235	705	8	Lower Catahoula Formation	220	do

299

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

BEST DOCUMENT AVAILABLE

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	A020	do	NE NE S34 T05N R14W	Jetco	254	750	7	do	150	N
do	A039	do	SW NW S25 T05N R14W	Rawls Springs Water Authority	230	680	8	Hattiesburg Formation	200	P
do	A060	do	NW NW S02 T05N R14W	Rain Nurseries		169	4	Miocene Series	75	C
do	B001	do	SE NE S31 T05N R13W	Hattiesburg	161	419	10	Lower Catahoula Formation	1065	P
do	B002	do	SW NW S32 T05N R13W	do	do	622	do	do	970	do
do	B003	do	do	do	164	610	do	do	953	do
do	B004	do	do	do	160	450	8	do	do	do
do	B005	do	SW NE S32 T05N R13W	do	do	621	do	do	990	do

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	B006	do	do	do	do	444	do	do	964	do
do	B007	do	do	do	do	635	10	do	908	do
do	B008	do	SE NW S23 T05N R13W	Union Oil Co.	152	260	4	do	90	N
do	B009	do	NE NW S26 T05N R13W	Union Tex. Co.	do	do	14	do	400	do
do	B010	do	SW NW S25 T05N R13W	Warren Petroleum Co.	170	289	5	do	90	do
do	B011	do	do	do	do	292	18	do	325	do
do	B012	do	SE SW S26 T05N R13W	do	153	289	5	do	90	do
do	B014	do	NE NW S26 T05N R13W	Mobil Oil Co.	154	252	8	do	300	do

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	B017	do	SE NE S31 T05N R13W	Hattiesburg	160	607	12	do	1000	P
do	B022	do	NW SE S08 T05N R13W	Eatonville High School		100	4	Hattiesburg Formation		do
do	B023	do	SE SW S32 T05N R13W	Hattiesburg	155	607	12	Lower Catahoula Formation	1000	do
do	B068	do	SW NE S31 T05N R13W	LaGrace Motel	185	86	4	Miocene Series	26	do
do	B069	do	S28 T05N R13W	Glendale Water Authority	183	654	10	do	300	do
do	B071	do	S13 T05N R13W	Eastabuchie Water Authority	240	810	8	do	200	do
do	B076	do	SW NE S35 T05N R13W	Happy Acres	130	100	6	Quaternary Alluvium	92	N
do	B080	do	NW NW S25 T05N R13W	Enterprise Prod.	250	320	12	Hattiesburg Formation	500	do

BEST DOCUMENT AVAILABLE

302

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	B081	do	do	do	do	352	do	do	do	do
do	B082	do	NW SE S35 T05N R13W	Enterprise Meat	140	100	6		305	do
do	B100	do	do	do	do	96	do		315	do
do	B102	do	SW NW S08 T05N R13W	Glendale Utility District	270	895	8	Miocene Series	554	P
do	B103	do	NE SW S35 T05N R13W	Mobil Oil Corp.	140	254	16	do	550	N
do	B104	do	SE NE S23 T05N R13W	Delta Underground Company	160	340	10	do	1000	do
do	B105	do	SW NW S25 T05N R13W	Fenix and Scissons	200	215	do	do	do	do
do	B106	do	do	do	220	330	do	do	do	do

303

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	B108	do	SW SW S24 T05N R13W	do	190	312	do	do	1200	do
do	B111	do	NW NE S25 T05N R13W	Enterprise Prod.	250	390	16	do	892	do
do	B120	do	SW NW S25 T05N R13W	Warren Petro	250	372	10	Hattiesburg Formation	1100	do
do	C060	do	SW NW S23 T05N R12W	Barrontown Water Authority	292	900	8	Miocene Series	200	P
do	C064	do	SW NE S22 T05N R12W	Barrontown Utility	295	885	10	do	300	do
do	D002	do	NE NW S36 T04N R13W	Hattiesburg AAB	143	195	18	Hattiesburg Formation	297	do
do	D004	do	NE SE S15 T04N R13W	Hattiesburg	do	485	do	Lower Catahoula Formation	1200	do
do	D005	do	NE NE S15 T04N R13W	do	do	678	do	do	do	do

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	D006	do	do	do	do	673	16	do	do	do
do	D007	do	NE SE S15 T04N R13W	do	do	688	do	do	do	do
do	D009	do	NW S23 T04N R13W	Marshall Durbin	150	678	8	do	350	N
do	D[illegible]0	do	do	do	do	do	6	do	550	do
do	D011	do	SE NW S23 T04N R13W	Dixie Pine Prod.	148	740	20	do	1000	do
do	D013	do	SW NW S03 T04N R13W	Coastal Chemical Co.	145	325	8	do		do
do	D014	do	SE NW S23 T04N R13W	Dixie Pine Prod.		501	do	do	600	do
do	D016	do	SW NW S04 T04N R13W	Hercules Powder Company	168	451	16	do	1387	do

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	D018	do	NE NE S10 T04N R13W	Southern Railroad		410	8	do		do
do	D020	do	NE NW S11 T04N R13W	Mississippi Power Company	135	110	12		400	do
do	D021	do	NE NE S11 T04N R13W	do	do	112	18		do	do
do	D022	do	do	do	do	108	12			do
do	D025	do	SW SW S25 T04N R13W	East Travillion High School		580	6	Lower Catahoula Formation	200	P
do	D027	do	SE NE S27 T04N R13W	Cen Forrestatcr		360	4	do		do
do	D028	do	NW NW S01 T04N R13W	East Forest Utility	155	124	12		600	N
do	D029	do	SW SW S01 T04N R13W	do	154	134	10		750	do

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	D030	do	NW NW S01 T04N R13W	do	160	390	8	Lower Catahoula Formation	500	do
do	D033	do	SW NW S04 T04N R13W	Hercules Powder Company	168	687	10	do	1000	do
do	D042	do	SE NE S27 T04N R13W	Plmrs Cross Water Authority	185	642	12	Lower Catahoula Formation	300	P
do	D044	do	do	do	do	do	do	Hattiesburg Formation	do	N
do	D045	do	SE NE S22 T04N R13W	Central Utility	158	694	8	Lower Catahoula Formation	250	do
do	D046	do	do	do	do	672	do	do	252	do
do	D060	do	NW SW S04 T04N R13W	Hercules Powder Company	168	671	18		1000	do
do	D061	do	NE SW S04 T04N R13W	Murray Envelope	140	105	4		72	do

307

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	D070	do	NE NW S04 T04N R13W	do	do	422	6	Hattiesburg Formation	158	do
do	D072	do	SE NE S15 T04N R13W	Pine Burr Pk. Co.	155	662	10	Lower Catahoula Formation	450	do
do	D084	do	S13 T04N R13W	Marshall Durbin	150	684	8	Lower Catahoula Formation	400	do
do	E005	do	NW NE S16 T04N R12W	Sunrise School	233	240	4	Hattiesburg Formation		P
do	E026	do	SE SW S09 T04N R12W	Sunrise Utility	265	900	8		200	P
do	E041	do	do	do	262	894	do	Miocene Series	do	do
do	F013	do	SE NW S16 T03N R13W	Dixie School		397	4	Hattiesburg Formation		do
do	F026	do	NE SE S20 T03N R13W	Dixie Water Authority	375	897	10	Miocene Series	300	do

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-6

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	F043	do	SE NE S20 T03N R13W	do	do	164	12	do	200	do
do	G001	do	NE NW S29 T03N R12W	Camp Shelby	303	400	10	Hattiesburg Formation	500	Z
do	G003	do	NW SW S27 T03N R12W	do		do	do	do	do	do
do	G004	do	NW SE S27 T03N R12W	do	297	do	do	do	do	do
do	G005	do	NE NE S27 T03N R12W	do	286	do	do	do	do	do
do	G006	do	NW SW S25 T03N R12W	do	281	do	do	do	do	do
do	G008	do	SW SW S29 T03N R12W	do	312	432	10	Hattiesburg Formation	551	do
do	G010	do	SE SW S32 T03N R12W	Town of McLaurin	375	638	8	Lower Catahoula Formation		P

309

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	G013	do	NW NW S29 T03N R12W	Camp Shelby	295	410	6	Hattiesburg Formation		Z
do	G015	do	S28 T03N R12W	do		406	10	do		do
do	G016	do	do	do	273	409	do	do	532	do
do	G017	do	do	do		414	do	do	500	do
do	G018	do	do	do		435	do	do	do	do
do	G019	do	do	do	273	438	do	do	do	do
do	G020	do	do	do	297	439	do	do	551	do
do	G021	do	do	do	290	425	do	do		do

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	G022	do	do	do	273	404	do	do	522	do
do	G023	do	do	do	261	400	12	do	855	do
do	G024	do	do	do	254	417	do	do		do
do	G025	do	do	do	273	319	do	do		do
do	G026	do	SE SE S32 T03N R12W	McLaurin Water Authority	330	630	6		100	P
do	G031	do	S32 T03N R12W	McLaurin Association		630	do	Lower Catahoula Formation	110	
do	G038	do	S06 T03N R12W	American Quasar	142	210	3	Hattiesburg Formation	85	Z
do	J001	do	SW SW S18 T02N R12W	Paul Johnson State Park		333	6	do		P

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	J005	do	NW NW S18 T02N R12W	do	220	315	do	do		do
do	J007	do	NE NE S18 T02N R12W	do		332	do	do		do
do	J008	do	NE SW S05 T02N R12W	McLaurin School	357	188	4	do		do
do	J011	do	S18 T02N R12W	Paul Johnson State Park		328	do	do		do
do	L032	do	NW SW S10 T01N R12W	Brooklyn Water Authority	210	850	6	Miocene Series	310	P
do	A032	Perry	SE SW S33 T05N R11W	Runnelstown FSH	140	295	do	do	100	N
do	A063	do	NW NE S21 T05N R11W	Runnelstown Water Authority	220	380	8	do	200	P
do	B049	do	NW SW S25 T05N R10W	F. Heywood	235	325	4	do	75	H

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	B051	do	NW SE S08 T05N R10W	Union Oil Co.	150	391	do	Hattiesburg Formation	100	N
do	C010	do	SW NW S31 T05N R09W	Richton	185	728	6	Lower Catahoula Formation	265	P
do	C014	do	SW SW S31 T05N R09W	Richton Ice Co.	180	77	4	Hattiesburg Formation	200	N
do	C015	do	SE SW S31 T05N R09W	Richton	163	736	10	Lower Catahoula Formation	488	P
do	C040	do	SW SE S31 T05N R09W	do	160	660	do	Miocene Series	300	do
do	C041	do	SE SE S10 T05N R09W	Northeast Perry Water Authority	320	520	8	Lower Catahoula Formation	180	do
do	C061	do	NE NE S15 T05N R09W	do	270	475	do	Miocene Series		do
do	D046	do	NE SW S12 T04N R11W	Runnelston Utility District	225	512	do	Hattiesburg Formation	150	do

313

TABLE 14-5

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	F003	do	NW NW S06 T04N R09W	Richton	175	564	8	Miocene Series	110	P
do	F016	do	NE NE S06 T04N R09W	County Hospital	170	94	4	Hattiesburg Formation	75	T
do	G005	do	NE NE S21 T03N R11W	U. S. Forest Service		352	do		2	P
do	G025	do	NE SW S19 T03N R11W	Jordon - O'Brien	255	560	3	Miocene Series	80	N
do	H006	do	SW SE S19 T03N R10W	New Augusta	114	723	do	Lower Catahoula Formation	50	P
do	H007	do	do	do	112	721	do	do	do	do
do	H009	do	NE NE S30 T03N R10W	do	190	1090	8	Miocene Series	200	do
do	H014	do	SE SW S19 T03N R10W	do	110	786	3	Lower Catahoula Formation	49	do

BEST DOCUMENT AVAILABLE

314

BEST DOCUMENT AVAILABLE

TABLE 14-8

SELECTED HIGH CAPACITY WATER SUPPLY WELLS IN THE STUDY AREA (CONTINUED)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION[1]	OWNER	ALTITUDE OF LAND SURFACE (FT)	DEPTH (FT)	DIAMETER (IN)	GEOLOGIC UNIT	PUMPAGE (GPM)	USE[2]
do	H020	do	NW SE S13 T03N R10W	Pel Tex Oil	105	336	do	Miocene Series	70	Z
do	H021	do	S13 T03N R10W	do	99	324	4	do	do	do
do	H022	do	NE SW S07 T03N R10W	Leaf River Forest Products	120	225	4	do	240	N
do	J060	do	NE SE S31 T03N R09W	Beaumont	88	550		do	500	P
do	K001	do	NE NE S16 T02N R11W	U. S. Army	252	88		Hattiesburg Formation		do
do	M011	do	SW SW S05 T02N R09W	Beaumont	95	666	11	Miocene Series	300	do
do	M014	do	NE NW S05 T02N R09W	do		575	2	do	75	do
do	N022	do	SE NW S01 T01N R11W	Janice Water Authority	291	571	6	do	162	do

Notes: 1. See Figure 14-12 for location

2. Use codes: C - Commercial
N - Industrial T - Institution
P - Public Supply Z - Other

Deep aquifers are used extensively for brine disposal in oil and gas fields. Disposal of brines is limited to formations already possessing high salinites. The principal geologic units used for disposal include the Tuscaloosa, Eutaw, Wilcox, Sparta, Cook Mountain, and Cockfield Formations. (See Table 12-1 for stratigraphic sequence.) Disposal wells are currently operating in the Hub Field in Marion County; the Baxterville Field in Lamar County; Petal Dome, Pistol Ridge, and Maxie Fields in Forrest County; and the Glazier and Camp Shelby Fields in Perry County. (See Figure 12-33 for location of oil and gas fields.) Disposal operations near the study area, in the Sand Hill Field in Greene County and the Ovett Field in Jones County, are also of interest because they are updip of the study area from the standpoint of regional ground-water movement (Bicker, 1972). The heaviest concentrations of disposal wells are in the Baxterville and Hub Fields. Most disposal wells in these fields inject into the Cook Mountain Formation. A few disposal wells in the Baxterville Field inject into the Wilcox Group. Disposal wells in the Petal Dome, Glazier, and Camp Shelby Fields inject into the Wilcox Group, whereas wells in the Pistol Ridge and Maxie Fields inject into the Cook Mountain Formation. Disposal wells in the Ovett and Sand Hill Fields inject into the Wilcox Group. Figure 14-12 shows the location of selected disposal wells in and around the study area. Table 14-6 summarizes well construction characteristics and average injection rates for disposal wells in the study area.

BEST DOCUMENT AVAILABLE

TABLE 14-6

SALINE WATER DISPOSAL WELLS WITHIN THE STUDY AREA

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION*	OPERATOR	ALTITUDE OF LAND SURFACE	INJECTION INTERVAL (FT)	GEOLOGIC UNIT	AVERAGE INJECTION RATE (BARRELS PER DAY)	INJECTION PRESSURE (PSI)
Miss. State Oil & Gas Board	Hub SWD #1	Marion	S17 T02N R14E	Exxon Corporation	N.A.	2350 to 2400	Claiborne Group	4800	N.A.
do	Chevron SWD #1	do	S9 T02N R18W	Chevron, USA, Inc.	121	2460 to 2510	Kosciusko (Sparta) Formation	244	300
do	Chevron SWD #2	do	NE NW S29 T02N R14E	do	130	2728 to 2778	do	51	450
do	Exxon Unit #2	do	S20 T02N R14E	Exxon Corporation	N.A.	2450 to 2550	Cook Mountain Formation	371	0
do	Baxterville Waste Water #32-13	Lamar	SW SW S32 T02N R16W	Pruet Production Company	319	2470 to 2500	do	279	0
do	T. W. Davis #1	do	SW SW S31 T02N R16W	Petroleum Management, Inc.	N.A	2450	do	4	30
do	L. J. Cameron #2	do	SE NE S32 T02N R16W	Vernon E. Faulconer	339	2470 to 2520	do	1524	300
do	Delta SWD#1	Forrest	S14 T05N R13W	Delta Underground Storage Co., Inc.	165	Below 3900	Wilcox Group	N.A.	0

*See Figure 14-12 for location

TABLE 14-6

SALINE WATER DISPOSAL WELLS WITHIN THE STUDY AREA (Continued)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION*	OPERATOR	ALTITUDE OF LAND SURFACE	INJECTION INTERVAL (FT)	GEOLOGIC UNIT	AVERAGE INJECTION RATE (BARRELS PER DAY)	INJECTION PRESSURE (PSI)
Miss. State Oil & Gas Board	W.E.Davis SWD#1-A	Marion	S12 TIN, R17W	North Central Oil Corporation	N.A.	2477' to 2577'	Cook Mountain Formation	N.A.	N.A.
do	Baxter-ville #1-8	Lamar	S9 TIN, R16W	Gulf Oil Corporation	267'	5108 to 5142	Wilcox Group	N.A.	N.A.
do	B. M. Stevens SWDW#6	Perry	S19 T4N, R9W	R. W. Tyson Producing Co.	208'	2555' to 2570'	do	1000	N.A.
do	Baxter-ville WWS#3-5	Lamar	S7 TIN, R16W	Gulf Oil Corporation	N.A.	N.A.	do	N.A.	N.A.
do	Baxter-ville WWS#4-6	Lamar	S32 T2N, R16W	Gulf Oil Corporation	N.A.	N.A.	do	N.A.	N.A.
do	Baxter-ville WWS#7-7	Lamar	S4 TIN, R16W	Gulf Oil Corporation	N.A.	N.A.	do	N.A.	N.A.
do	Baxter-ville WWS#4-5	Lamar	S5 TIN, R16W	Gulf Oil Corporation	N.A.	N.A.	do	N.A.	N.A.

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-6

SALINE WATER DISPOSAL WELLS WITHIN THE STUDY AREA (Continued)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION*	OPERATOR	ALTITUDE OF LAND SURFACE	INJECTION INTERVAL (FT)	GEOLOGIC UNIT	AVERAGE INJECTION RATE (BARRELS PER DAY)	INJECTION PRESSURE (PSI)
do	Scott SWD #1	do	S14 T05N R13W	Scott Butane Gas Company, Inc.	N.A.	Below 3700	do	N.A.	N.A.
Miss Geological Survey†	Max Watts SWD #1	do	S14 T05N R13W	Mobil Oil Corporation	N.A.	3362 to 3404	do	N.A.	N.A.
do	Warren SWD #1	do	S13 T05N R13W	Warren Petroleum Corporation	N.A.	3482 to 4447	do	N.A.	N.A.
do	Fee #1	do	S14 T05N R13W	Allied Chemical Corporation	N.A.	2540 to 3136	do	N.A.	N.A.
do	Enterprise SWD #1	do	S13 T05N R13W	Enterprise Products Company	N.A.	2500 to 3200	do	N.A.	N.A.
Miss. State Oil & Gas Board	S. F. Hinton SWD #2	Perry	NE NW S30 T04N R09W	R. W. Tyson Production Company	174	3492 to 3512	do	878	0
do	Shell USA #8-6	do	SE NW S8 T02N R10W	Shell Oil	251	5390 to 5405; 5413 to 5425; 5432 to 5450	do	2	1400

TABLE 14-6

SALINE WATER DISPOSAL WELLS WITHIN THE STUDY AREA (Continued)

REPORTING AGENCY	WELL NO.	COUNTY	LOCATION*	OPERATOR	ALTITUDE OF LAND SURFACE	INJECTION INTERVAL (FT)	GEOLOGIC UNIT	AVERAGE INJECTION RATE (BARRELS PER DAY)	INJECTION PRESSURE (PSI)
Miss. State Oil & Gas Board	L.L. Majors #1	Jones	SE NW S20 TO6N R11W	N.C. Ginther, Warren & Co.	N.A.	3830 to 3840	Wilcox Group	1000	N.A.
do	A.G. Carter SWD #1	Jones	SW NE S29 TO6N R11W	Jett Drilling Co.	227	4306 to 4370	do	N.A.	0
do	A.G. Carter #4	Jones	SW NE S29 TO6N R11W	R. W. Tyson Production Co., Inc.	N.A.	3745 to 4025	do	2000 to 7000	0
do	L.L. Majors #3	Jones	NW NE S29 TO6N R11W	R. W. Tyson Production Co., Inc.	278	4005 to 4025	do	1100	0
do	M.W. McClellan #2A	Jones	SE SW S28 TO6N R11W	do	252	4005 to 4035	do	1600	N.A.
do	O.H. Shows #1-A	Jones	NE NE S29 TO6N R11W	do	237	3852 to 4015	do	3000	N.A.
do	O.H. Shows #2	Jones	NE SE S29 TO6N R112	do	238	4110 to 4193	do	1555	N.A.
do	H.L. Vickers Sr SWD #1	Jones	SE NW S33 TO6N R11W	do	N.A.	3978 to 4110	do	2500	N.A.

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 14-6

SALINE WATER DISPOSAL WELLS WITHIN THE STUDY AREA (Continued)

	WELL NO.	COUNTY	LOCATION*	OPERATOR	ALTITUDE OF LAND SURFACE	INJECTION INTERNAL (FT)	GEOLOGIC UNIT	AVERAGE INJECTION RATE (BARRELS PER DAY)	INJECTION PRESSURE (PSI
Miss. State Oil & Gas Board	H.L. Vickers #2	Jones	SE NW S23 T06N R11W	R. W. Tyson Production Company	N.A.	4080 to 4120	Wilcox Group	1500	N.A.
do	Z.A. Henderson Unit 33-5 #1	Greene	SW NW S33 T05N R8W	E. V. Cleveland, Jr.	218	3910 to 3940	do	1700	300
do	Hubbard A SWD	Greene	SW SW S10 T04N R8W	Cities Service Oil Co.	237	4450 to 4485	do	100 to	460
do	Hubbard #1	Greene	SE SW S10 T04N R8W	E. V. Cleveland, Jr.	N.A.	4470 to 4490	do	640	275

Only one disposal well is located near a candidate salt dome. This well is in the Camp Shelby Field near Cypress Creek Dome and its discharge is into the lower part of the Wilcox Group. Total discharge at this site in 1979 was 96,971 liters (25,620 gal). Average discharge of disposal wells in the study area in 1979 was approximately 9,462 liters (2,500 gal) per well.

14.3 HYDROLOGIC CHARACTERIZATION OF CANDIDATE DOMES

The hydrology in the vicinity of Richton, Cypress Creek, and Lampton Domes was investigated. The knowledge gained from the regional hydrologic study, together with data analyzed at sites around specific domes, was used in defining hydrologic conditions around these domes.

14.3.1 RICHTON DOME: Data for hydrologic analyses are available from a number of locations in the vicinity of Richton Dome (Figure 14-2). One geologic data collection site was located over the dome (MRIG-9) and another approximately 6 km (4 mi) north of the dome (MRIG-10). A hydrogeologic data collection site was located approximately 5 km (3 mi) southwest of the dome (MRIH-11). Twenty-four surface-water chemical and physical parameter measuring sites are located around the dome. Numerous other chemical and physical ground-water parameter data available from USGS in the domal area were identified and retrieved from the USGS National Data Storage and Retrieval System (WATSTORE).

14.3.1.1 Surface-Water Hydrology: Richton Dome is located along the drainage divide between Bogue Homo and Thompson Creek watersheds (Figure 14-2). Both creeks are tributaries to the Leaf River.

Bogue Homo watershed drains an area of 1,093 km^2 (422 mi^2) of Perry, Jones, Wayne, and Jasper Counties. A small portion of the headwaters of Bogue Homo are in the Jackson Prairie Physiographic Subprovince. The remainder of the watershed is in the Piney Woods Subprovince.

The watershed is characterized by gently rolling to hilly topography developed by mature dendritic drainage. Relief in Bogue Homo watershed varies from 24 to 171 meters (80 to 560 ft) above MSL. Stream bed slopes vary from 3 m/km (15 ft/mi) in the headwaters to about 0.5 m/km (2.6 ft/mi) near the mouth. The average fall of the main channel is 1.0 m/km (5.5 ft/mi). Bogue Homo meanders excessively across its 2.4-km (1.5-mi)-wide flood plain. This broad flood plain with its low gradient has resulted in a swampy marsh along almost 80 percent of the stream's course.

Mean annual precipitation for Bogue Homo watershed is 1,473 mm (58 in). Average annual runoff is 490 mm (19.3 in).

Thompson Creek watershed drains an area of 611 km^2 (236 mi^2), including parts of Perry, Wayne, and Jones Counties. The entire watershed is within the Piney Woods Physiographic Subprovince.

The topography of the Thompson Creek watershed is similar to that of the Bogue Homo watershed. The area is characterized by gently rolling to hilly topography with moderate relief and mature, dendritic drainage patterns. Relief in the watershed varies from 21 to 107 meters (68 to 350 ft) above MSL. Stream bed slopes vary from 1.6 m/km (8.8 ft/mi) in the headwaters to 0.6 m/km (3.0 ft/mi) near the mouth. The average fall of the main channel is 1.2 m/km (6.2 ft/mi). Thompson Creek, like Bogue Homo, meanders across a broad flood plain. The flood plain averages 1.9 km (1.2 mi) in width. The broad flood plain and the low channel gradient create a swamp through the stream's middle reaches.

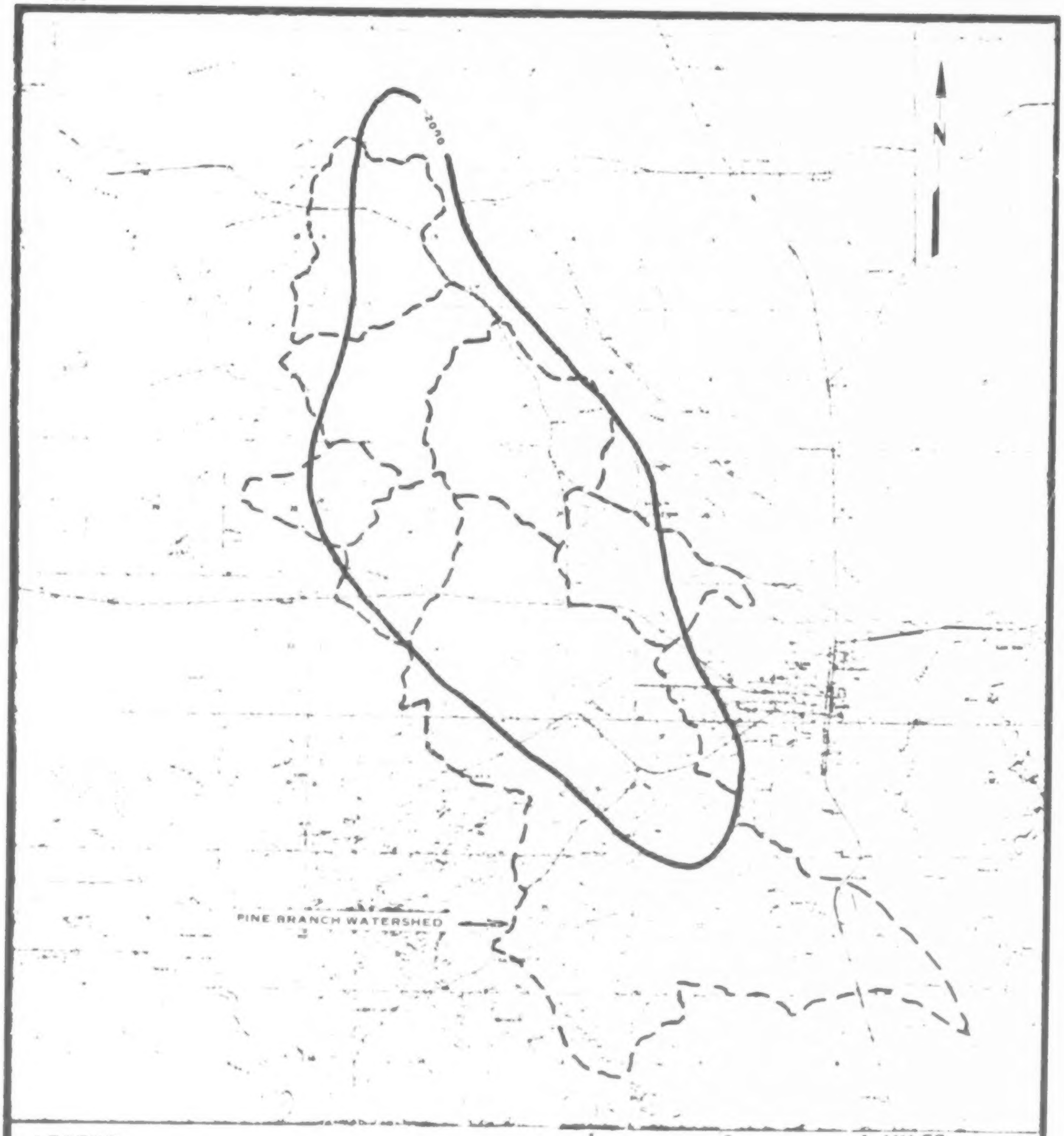
Mean annual precpitation for the Thompson Creek watershed is 1,524 mm (60 in). Average annual runoff is 500 mm (19.7 in).

14.3.1.1.1 Domal Area Drainage - The topography over Richton Dome is gently rolling to hilly and is characterized by mature, dendritic drainage. Surface elevations at the dome vary from 87 meters (287 ft) above MSL in the central area to 50 meters (164 ft) above MSL along Pine Branch at the southeastern edge of the domal area.

The domal area is drained radially by several minor tributaries to Bogue Homo and Thompson Creek (Figure 14-13). The most significant flood potential over the dome is from Pine Branch, a tributary to Thompson Creek. Pine Branch watershed covers 11 km^2 (4.2 mi^2) and it drains approximately 50 percent of the site area.

14.3.1.1.2 Historical Floods - There are no published records of floods in the domal area. The only USGS gauging station in

AF 12338A



LEGEND

- - - - - SURFACE DRAINAGE DIVIDE

— 2000 — LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME. DATUM IS MEAN SEA LEVEL

1 0 1 MILES

1 0 1 KILOMETERS

BASE FROM USGS 1:24,000 QUADRANGLES.
CONTOUR INTERVAL 10 FEET.

PREPARED RSM DATE 5-30-80
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED JMF DATE 5/20/80
T-1159-2

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

TOPOGRAPHY AND DRAINAGE
IN VICINITY OF RICHTON DOME

JOB NO MV9600 FIGURE 14.13

BEST [illegible]

either of the two watersheds is on Bogue Homo near Richton, Mississippi (Station Number 02474600), about 10 km (6 mi) upstream from the dome site (Figure 14-2). Streamflow records are available at this station for the period from October, 1970 to the present. The maximum flood of record at this gauge occurred on December 28, 1973. The maximum discharge for this flood was 620,208 l/sec (21,900 ft^3/sec), or approximately 1,812 l/sec (64 ft^3/sec) per square mile of drainage area. The corresponding stage was 44 meters (144.6 ft) above MSL (U.S. Geological Survey, 1978).

14.3.1.1.3 Flood-Plain Delineation - Flood-plain delineation was based on the probable maximum flood of streams overlying the dome. The probable maximum flood was calculated by using:

(1) Published probable maximum precipitation values for the domal area
(2) Estimated hydrologic-response characteristics of the watershed
(3) The U.S. Department of Agriculture, Soil Conservation Services (SCS) flood-routing-computer program published as Technical Report No. 20 (TR-20)
(4) The Army Corps of Engineers stream-backwater-profile computer program published as HEC-2.

General methodology involved the determination of peak discharges at several points on the stream channel and computation of associated water surface profiles. (For details regarding these calculations and analysis methods, see the Mississippi Study Area Appendix.)

Maximum flooding on streams crossing the domal area would inundate about 264 hectares (653 acres), or approximately 12 percent, of the area defined by the surface projection of the -610-meter (-2,000-ft)-MSL salt dome contour. This flooding represents the probable maximum inundation over the Pine Branch watershed and the estimated maximum inundation for other minor streams. The area that would be covered by probable maximum flooding is shown in Figure 14-14.

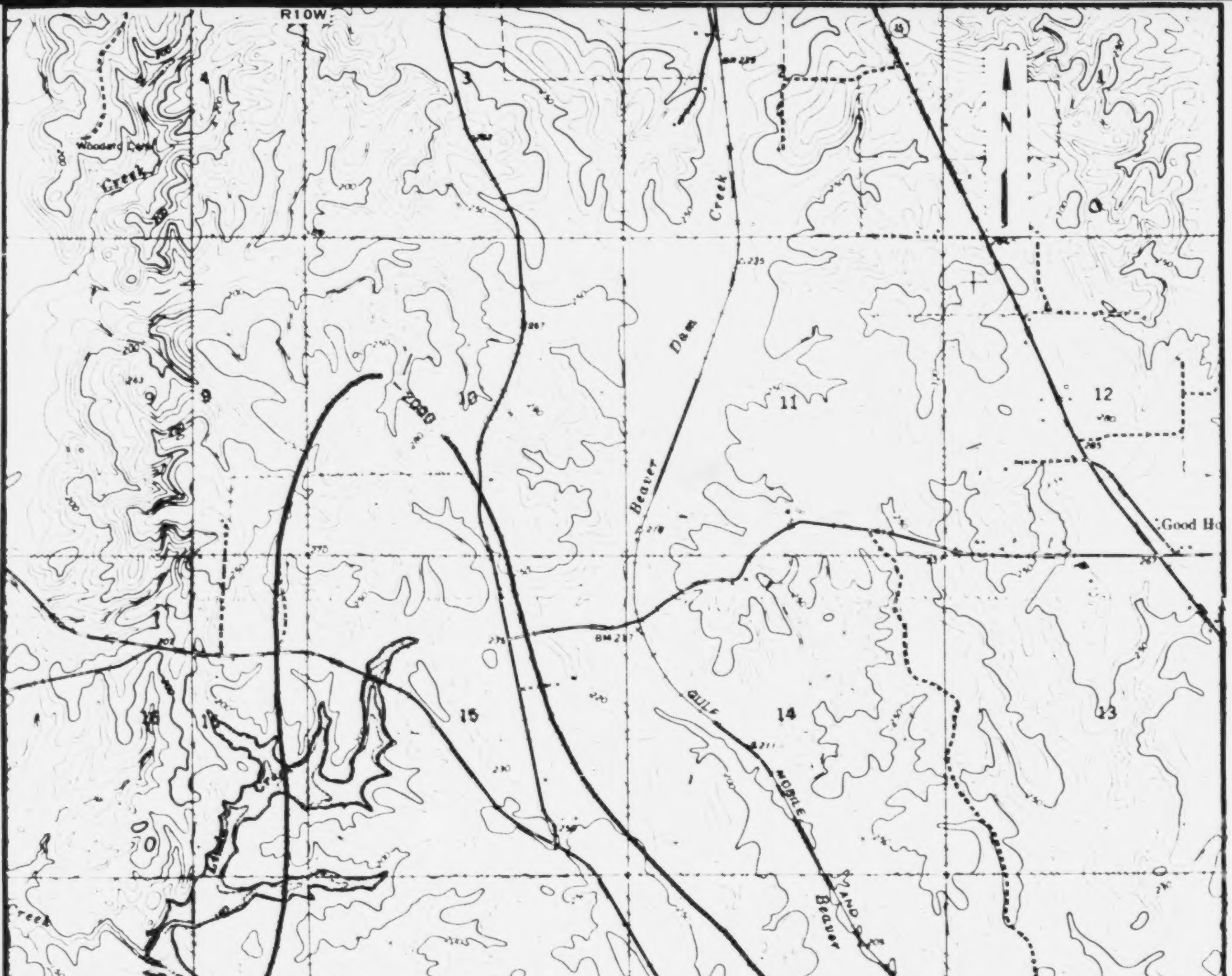
It is unlikely that the area inundated by the probable maximum flood would exceed that computed here. Parametric values included in the flood computations were estimated conservatively to produce high values of runoff and stream depths. Flooding was also taken into consideration on the basis of existing land use so that the domes could be evaluated on an equal basis.

14.3.1.2 Ground-Water Hydrology: The sequence of hydrogeologic units at Richton Dome is similar to that which occurs regionally. Tertiary deposits include, in ascending order, the Midway, Wilcox, Claiborne, Jackson and Vicksburg Groups and the Chickasawhay, Catahoula, and Hattiesburg Formations. These are overlain by deposits of Quaternary age which include, in ascending order, the Citronelle Formation, terrace deposits, and alluvium. The Hattiesburg Formation is the basal unit directly overlying Richton Dome caprock.

14.3.1.2.1 Domal Area Hydrogeology - The aquifer system of interest in the vicinity of Richton Dome consists of the entire

BEST DOCUMENT AVAILABLE

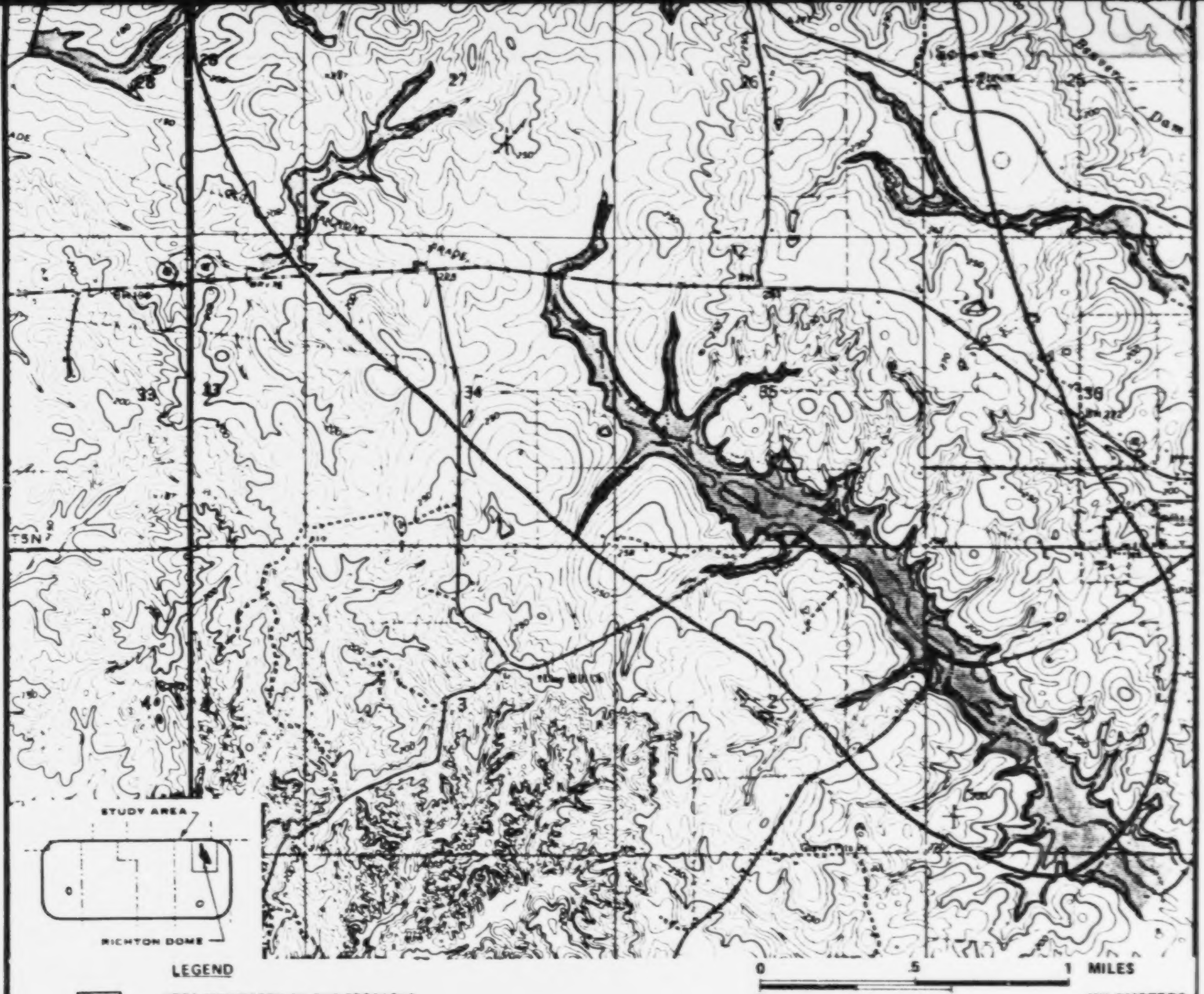
328


R10W
Woodard Creek
Creek
3
2
4
Beaver Dam Creek
9
10
11
12
2000
Good Ho
BM 237
15
14
13
16
GULF MOBILE AND OHIO
Beaver Dam Creek
21
22
23
24
Fox Branch
Creek
Creek

BEST DOCUMENT AVAILABLE

328 A

FIGURE 14-14



LEGEND

▭ AREA INUNDATED BY THE PROBABLE MAXIMUM FLOOD

— - 2000 — LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME DATUM IS MEAN SEA LEVEL

BASE FROM USGS 1 24,000 QUADRANGLES.
CONTOUR INTERVAL 10 FEET.

PREPARED RSM DATE 5-30-80
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE ______
T-1160-2

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
RICHTON DOMAL LOCATION
SHOWING AREA INUNDATED BY
PROBABLE MAXIMUM FLOODING

JOB NO MV9600 FIGURE 14-14

sequence of units of Tertiary and Quaternary ages above the Midway Group (Figure 14-15). One well at Site MRIH-11 penetrated the total thickness of the Midway Group. Analysis of data from this well indicates that the base of the Midway Group is composed predominantly of relatively impermeable clay.

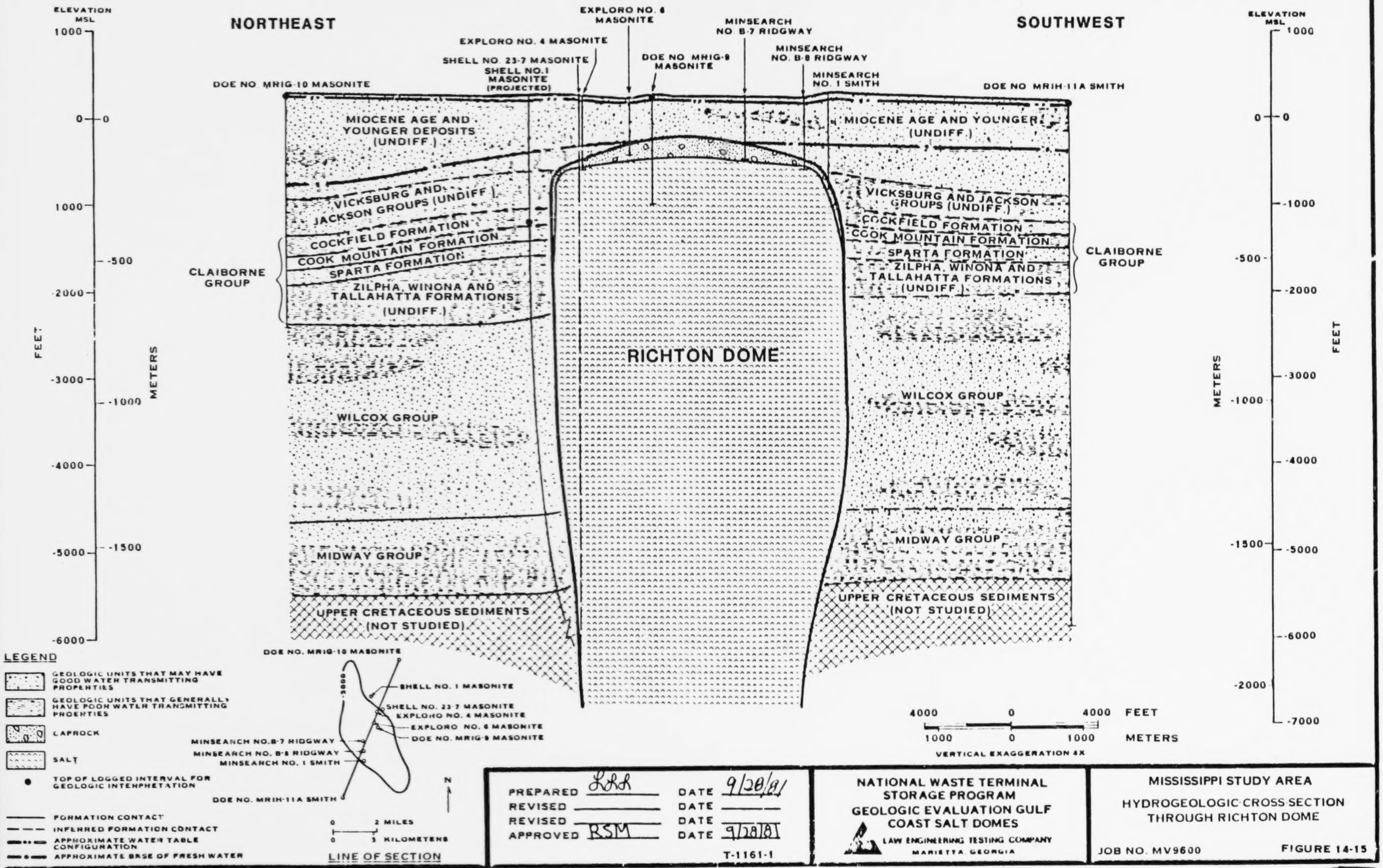
Three test wells were completed in the Wilcox Group near Richton Dome for collecting hydrogeologic data. One test well was completed in the Upper Wilcox Group at Site MRIG-10. One test well was completed in the Upper Wilcox Group and one in the Lower Wilcox Group at Site MRIH-11. Hydraulic conductivities calculated from aquifer tests at these sites are 4 m/day (14 ft/day), 3 m/day (9 ft/day), and 27 m/day (90 ft/day), respectively. These tests indicate that the sand beds in the Upper and Lower Wilcox Group at Sites MRIG-10 and MRIH-11 have good hydraulic properties.

Water pumped during these tests was saline. The total dissolved-solids content of water from the Upper Wilcox Group at Sites MRIG-10 and MRIH-11 was approximately 14,000 and 18,000 mg/l (14,000 and 18,000 ppm), respectively. Water from the Lower Wilcox Group at Site MRIH-11 had a total dissolved-solids content of approximately 110,000 mg/l (110,000 ppm). The differences in salinity content between the Upper and Lower Wilcox aquifers may indicate lack of hydraulic communication between these two aquifers.

Selected data for hydrogeological analyses were collected from the Cook Mountain Formation. One test well at Site MRIH-11 was completed in the Cook Mountain Formation. Aquifer testing at this well gave a relatively low hydraulic conductivity of 0.0009 m/day (0.003 ft/day). Water pumped during testing was saline, the total dissolved-solids content of the water being approximately 7,000 mg/l (7,000 ppm).

Four test wells for hydrogeologic-data collection were completed in the Hattiesburg and Catahoula Formations. One test well was completed in the Catahoula Formation. This well was located at Site MRIH-11. Aquifer testing gave a hydraulic conductivity value of 1.0 m/day (3.4 ft/day). Water pumped during this test was saline, the total dissolved-solids content of the water being approximately 10,000 mg/l (10,000 ppm). Three test wells were completed in the Hattiesburg Formation. One well was located at each of the three test sites, MRIG-9, MRIG-10, and MRIH-11. Aquifer testing gave a hydraulic conductivity value of 0.25 m/day (0.85 ft/day) at Site MRIG-10, 1.5 m/day (5 ft/day) at Site MRIG-9, and 274 m/day (900 ft/day) at Site MRIH-11. Water pumped during testing at these sites was fresh, with the total dissolved-solids content of the water varying from 37 to 272 mg/l (37 to 272 ppm) between sites.

Two subregional hydraulic conductivity trends in the vicinity of the dome are apparent from the testing program and they should be noted. First, the hydraulic conductivity of the Hattiesburg Formation to the northeast and over the dome is much less than that southwest of the dome. This difference results primarily from changes in lithology. Second, the hydraulic conductivity of the Upper Wilcox Group northeast of the dome is much less than that southwest of the dome. This difference also results primarily from changes in lithology.


ELEVATION MSL
NORTHEAST
SOUTHWEST
FEET
METERS
1000
0
1000
-500
2000
3000
-1000
4000
5000
-1500
6000
-2000
-5000
-6000
-7000
DOE NO. MRIG-10 MASONITE
SHELL NO. 1 MASONITE (PROJECTED)
SHELL NO. 23-7 MASONITE
EXPLORO NO. 4 MASONITE
EXPLORO NO. 6 MASONITE
DOE NO. MRIG-9 MASONITE
MINSEARCH NO. B-7 RIDGWAY
MINSEARCH NO. B-8 RIDGWAY
MINSEARCH NO. 1 SMITH
DOE NO. MRIH-11A SMITH
MIOCENE AGE AND YOUNGER DEPOSITS (UNDIFF.)
MIOCENE AGE AND YOUNGER (UNDIFF.)
VICKSBURG AND JACKSON GROUPS (UNDIFF.)
COCKFIELD FORMATION
COOK MOUNTAIN FORMATION
SPARTA FORMATION
ZILPHA, WINONA AND TALLAHATTA FORMATIONS (UNDIFF.)
CLAIBORNE GROUP
RICHTON DOME
WILCOX GROUP
MIDWAY GROUP
UPPER CRETACEOUS SEDIMENTS (NOT STUDIED)
LEGEND
GEOLOGIC UNITS THAT MAY HAVE GOOD WATER TRANSMITTING PROPERTIES
GEOLOGIC UNITS THAT GENERALLY HAVE POOR WATER TRANSMITTING PROERTIES
CAPROCK
SALT
TOP OF LOGGED INTERVAL FOR GEOLOGIC INTERPRETATION
FORMATION CONTACT
INFERRED FORMATION CONTACT
APPROXIMATE WATER TABLE CONFIGURATION
APPROXIMATE BASE OF FRESH WATER
-3000
N
0 2 MILES
0 3 KILOMETERS
LINE OF SECTION
4000 0 4000 FEET
1000 0 1000 METERS
VERTICAL EXAGGERATION 4X

PREPARED LRR DATE 9/28/81
REVISED DATE
REVISED DATE
APPROVED RSM DATE 9/28/81
T-1161-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

HYDROGEOLOGIC CROSS-SECTION THROUGH RICHTON DOME

JOB NO. MV9600

FIGURE 14-15

BEST DOCUMENT AVAILABLE

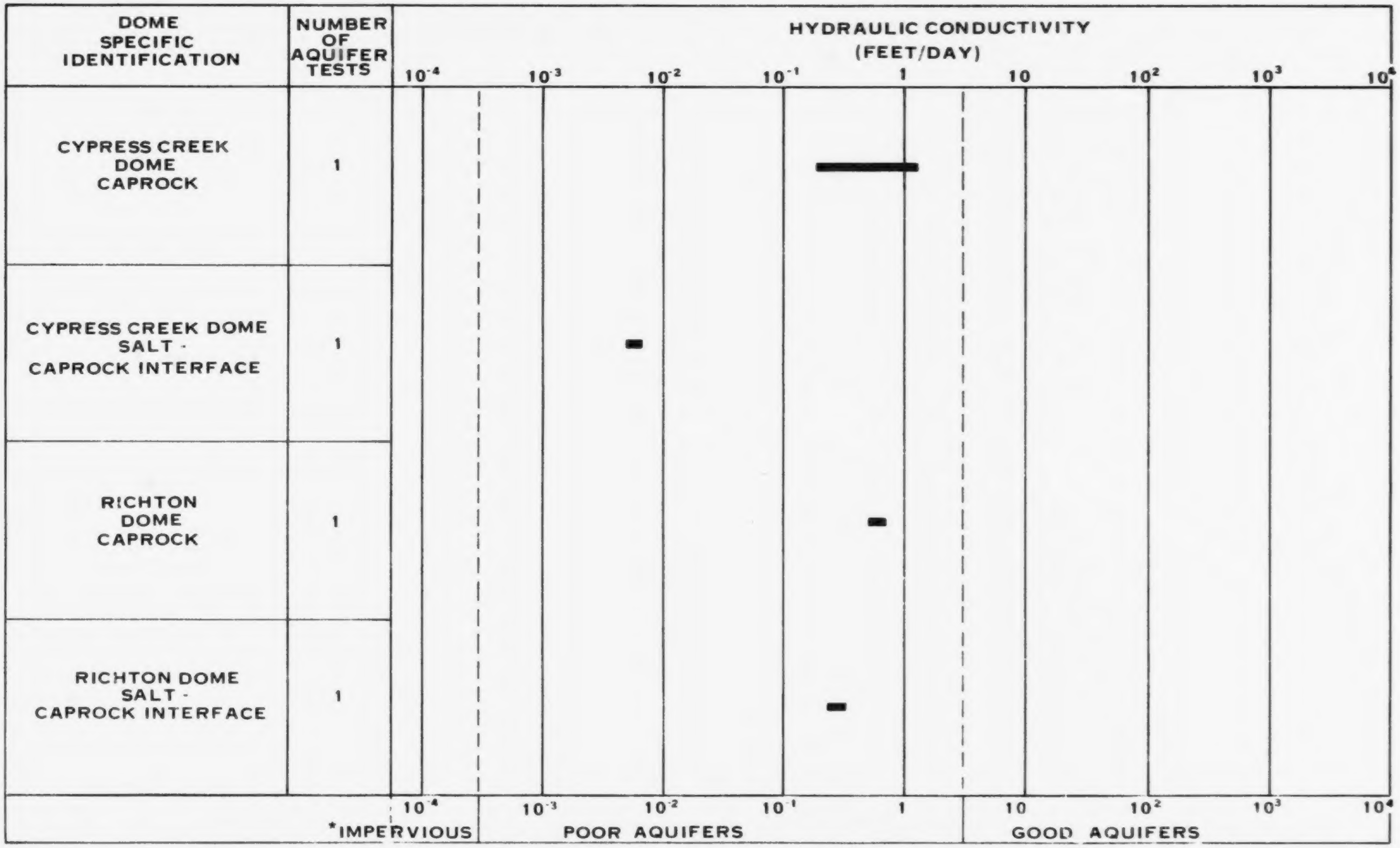
The caprock overlying Richton Dome was tested for hydraulic properties (Table 14-7) by completion of a well in the caprock zone at Site MRIG-9. Testing indicated that the hydraulic conductivity of the caprock in the vicinity of this well was 0.2 m/day (0.8 ft/day). Water pumped from the caprock was saline, the total dissolved-solids content of the water being approximately 11,000 mg/l (11,000 ppm).

Water pumped from the upper part of the caprock during aquifer testing showed decreases in conductance during the testing period. This observation suggests that induced downward leakage of fresh water may have occurred from the overlying Hattiesburg Formation. Further investigation is needed to define the degree of hydraulic connection between the porous, upper part of the caprock and the overlying Hattiesburg Formation.

The hydraulic properties of the caprock at the caprock-salt interface also were investigated. A slug test was performed using straddle packers. This test gave a hydraulic conductivity of 0.15 m/day (0.5 ft/day).

Ground-water movement in the caprock appears to be primarily through fractures, joints, and solution channels in the upper portion of the caprock. Several solution channels were observed in the upper 7 meters (23 ft) of caprock core that was collected at Site MRIG-9. These channels were generally less than 10 mm (0.39 in) in size. Also, the computed permeability index in the upper portion of the caprock was relatively high in comparison to that throughout the remainder of the caprock at this location.

AF 12338 B



DOME SPECIFIC IDENTIFICATION	NUMBER OF AQUIFER TESTS
CYPRESS CREEK DOME CAPROCK	1
CYPRESS CREEK DOME SALT - CAPROCK INTERFACE	1
RICHTON DOME CAPROCK	1
RICHTON DOME SALT - CAPROCK INTERFACE	1

*ADAPTED BY F. L. HOTES, FROM FAIR & GEYER, FIG. 9-4' P.221 "WATER SUPPLY & WASTE DISPOSAL" WILEY, 1956, AFTER A, CASAGRANDE, 1970.

PREPARED		DATE	[illegible]
REVISED	C42	DATE	
REVISED		DATE	
APPROVED	[illegible]	DATE	[illegible]

T-1457-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
DOME SPECIFIC
AQUIFER TEST SUMMARY

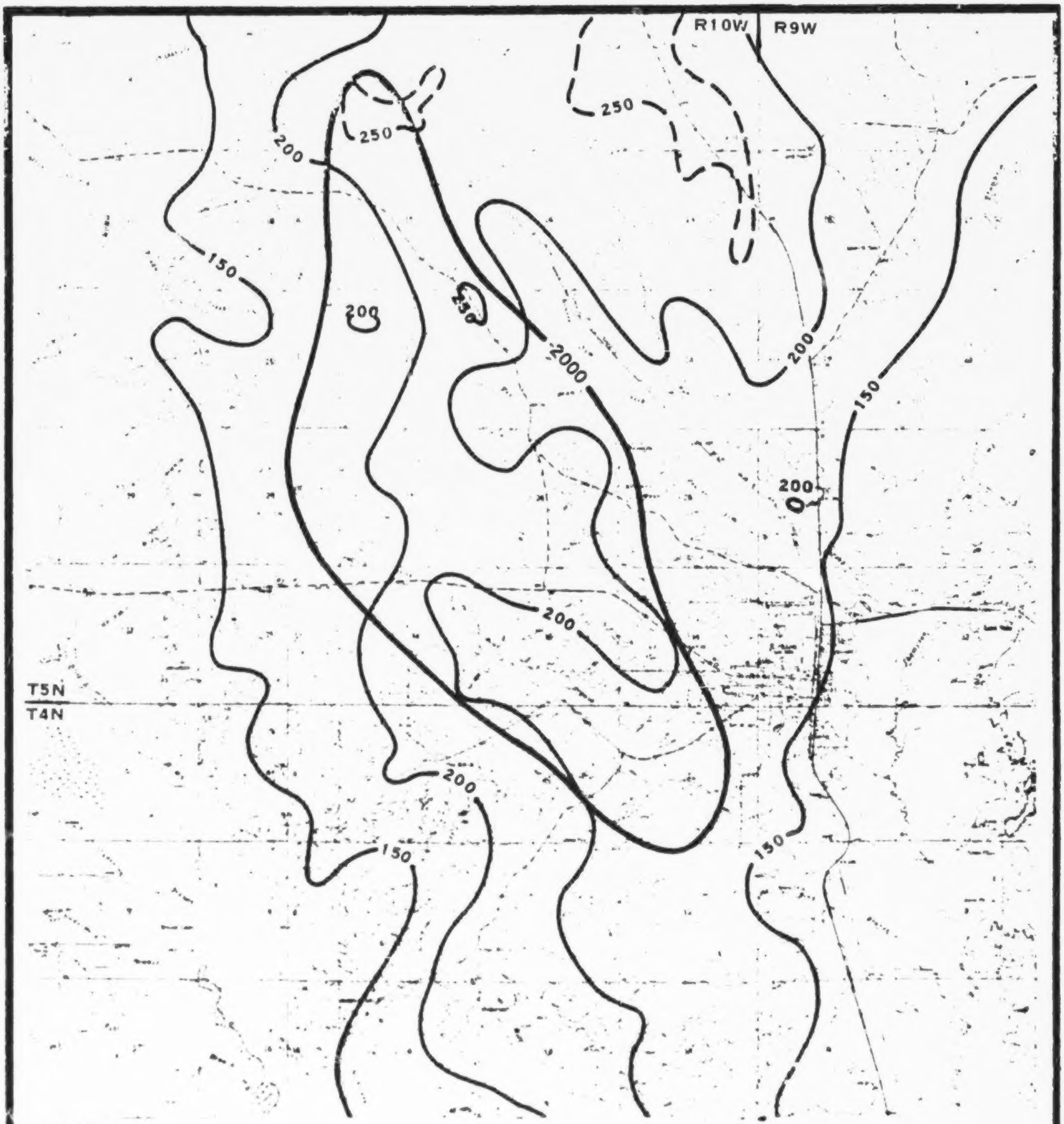
JOB NO. MV9600

TABLE 14-7

Flow directions at shallow depths in the aquifer system (less than about 30 meters (100 ft) in the vicinity of Richton Dome were determined from the shape of the water table (Figure 14-16). Water-table contours were drawn using altitudes of streams and water levels in wells. Water-level information was obtained from topographic maps, shallow wells drilled by LETCo, and data supplied by the USGS. Flows are generally from areas of high water-table elevations, under the north-south trending ridge that overlies the domal area, to areas of low elevations of the water table in the Bogue Homo and Thompson Creek stream valleys. The north-south trending ridge is a local recharge area. Bogue Homo and Thompson Creek and its tributaries are local discharge areas.

Horizontal flow directions deeper in the aquifer system were determined from the hydraulic gradient in cross section A-A' (Figure 14-8). The general slopes of the potentiometric surfaces at 244, 701, and 914 meters (800, 2,300 and 3,000 ft) below MSL are southerly in the vicinity of Richton Dome, indicating that flow at these elevations is southerly near the dome.

Vertical flow directions were determined from an analysis of the vertical distribution of environmental heads (Figure 14-9). Environmental heads at Site MRIH-11 southwest of the dome suggest that upward flow is occurring at this site from the Cook Mountain Formation to the Catahoula and Hattiesburg Formations, and that downward flow may be occurring from the Cook Mountain Formation to the Upper Wilcox Group at Site MRIH-11. The head distribution also suggests that upward flow occurs from the Lower to the Upper Wilcox Group at Site MRIH-11. Injection stresses from disposal


R10W
R9W
250
250
200
200
200
200
200
200
200
150
150
150
150
2000
250
T5N
T4N

LEGEND

— 150 — WATER-TABLE CONTOUR. CONTOUR INTERVAL 50 FEET. DASHED WHERE APPROXIMATE. DATUM IS MEAN SEA LEVEL.

—2000— LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME. DATUM IS MEAN SEA LEVEL.

1 0 1 MILE

1 0 1 KILOMETER

BASE FROM USGS 1:24,000 QUADRANGLES. CONTOUR INTERVAL 10 FEET.

PREPARED ____ DATE ____
REVISED ____ DATE ____
REVISED ____ DATE ____
APPROVED ____ DATE ____
T-2102-0

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
WATER TABLE IN
VICINITY OF RICHTON DOME

JOB NO. MV9600 FIGURE 14-16

BEST DOCUMENT AVAILABLE

335

wells probably result in higher heads in the Cook Mountain Formation at Site MRIH-11 than would be expected under natural conditions, thus resulting in divergent upward and downward flows from this formation. The head distribution at Site MH-4 south of the dome suggests that upward flow is occurring at this site throughout the depth of the aquifer system.

The base of the fresh-water zone in the vicinity of the dome was identified (see Figures 14-5, 14-9, and 14-15). The shape of the fresh-water base reflects the presence of the dome. The fresh-water base is approximately -232 meters (-760 ft) MSL at site MRIG-10 northeast of the dome, -85 meters (-280 ft) MSL at Site MRIG-9 over the dome, and -137 meters (-450 ft) MSL southwest of the dome at Site MRIH-11.

The fresh-water base remains relatively high in the Miocene deposits south of Richton Dome in the area between Richton and Cypress Creek Domes. Several reasons for this can be hypothesized. Upward flow in this area may be bringing saline water to higher elevations. Also, changes in lithologies in the Miocene deposits in this area could be responsible for maintaining the base of fresh water at a high elevation. Finally, saline water at high elevations in Miocene deposits south of Richton Dome might be expected if salt dissolution is occurring at the dome. Further investigation is needed to explain the reasons for the high fresh-water base south of Richton Dome.

14.3.1.2.2 Ground-Water Flow-Time Analysis - The natural route for ground-water flow in the vicinity of Richton Dome is southerly and upward. Horizontal ground-water movement in the vicinity of the dome is in a southerly direction at the -244, -701, and -914-meter (-800, -2,300, and -3,000-ft)-MSL elevations. Ground-water velocities are on the order of 0.9, 6, and 2 m/yr (3, 20, and 7 ft/yr), respectively at Site MRIH-11 near the dome at these elevations. The environmental head data at this site suggest that, under natural conditions, there is an upward vertical component to the ground-water flow.

A report by Pacific Northwest Laboratories (1979) inspired Law Engineering to investigate average vertical ground-water flow-times from various depths below the fresh-water base to the base of the fresh-water surface at Richton Dome. An objective of the analysis was to ascertain if significant differences between vertical ground-water flow times exist among the candidate domes. The desire for quantitative answers and the lack of some specific data dictated a procedure requiring a number of assumptions. These assumptions included not only a simplified model but also an empirical selection of numerical values for most of the important parameters. A listing of these assumptions, a discussion of their significance, and the computation procedure are presented by Slaughter (1981). The most significant variables directly available from measured data are vertical head differences and the ratio of the length of the travel path in shale or clay to the total length of the travel path. These lengths were assumed to be vertical; thus, the ratio, which is a function of the lithology, was obtained by use of geophysical logs from selected holes at the site.

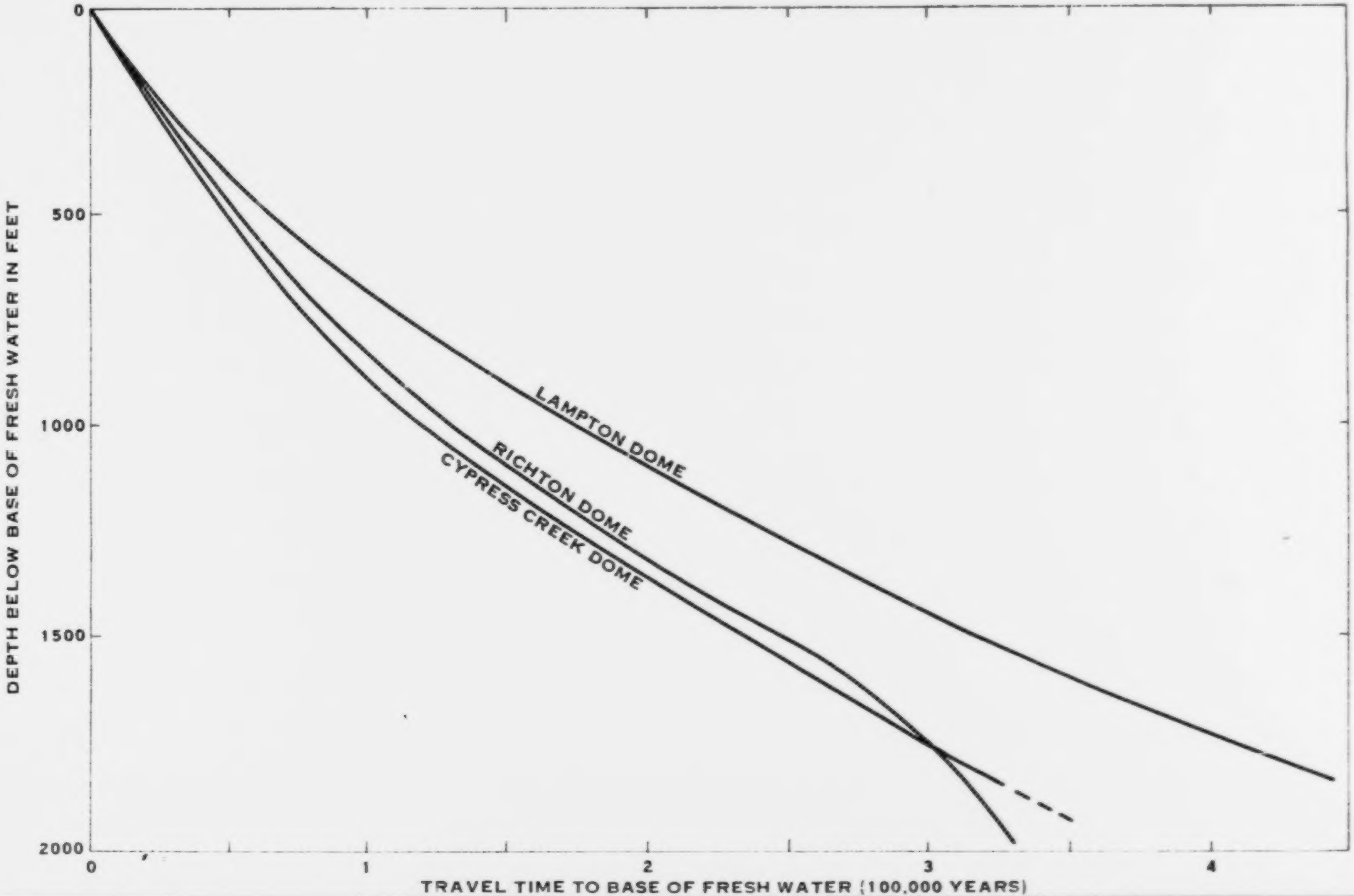
Vertical flow times, computed on the basis of available data and estimated parameters, varied between approximately 52,000 years from a point 152 meters (500 ft) below the base of fresh water to approximately 332,000 years from a point 610 meters (2,000 ft) below the fresh-water base at Richton Dome (Figure 14-17). The estimated vertical flow velocity averaged about 0.002 m/yr (0.007 ft/yr). These results indicate that the estimated average vertical ground-water flow times are long and that significant differences in vertical flow times between Richton Dome and the other candidate domes cannot be substantiated.

The flow analysis suggests that ground water can move south and away from the dome faster than it can move upward to the fresh-water base. Horizontal ground-water velocities between -701 and -914 meters (-2,300 and -3,000 ft) MSL are about three orders of magnitude faster than the estimated vertical velocities near Richton Dome. The estimated horizontal flow time from site MRIH-11 near Richton Dome to Site MCCH-3 near Cypress Creek Dome is about 25,000 years.

The model used for the flow-time analysis assumed flow through the intergranular pore spaces in the geologic formations. Flow through secondary openings such as joints or fractures was not identified in this study, and thus it was not considered in this analysis.

14.3.1.3 Water Chemistry: The chemical composition of water in the vicinity of Richton Dome was investigated. Field parameters, including water temperature, dissolved oxygen, conductance and

BEST DOCUMENT AVAILABLE



PREPARED	CAS	DATE	11/20/81	
REVISED		DATE		
REVISED		DATE		
APPROVED	DJP	DATE	12/4/81	
				1-1194-2

NATIONAL WASTE TERMINAL
STORAGE PROGRAM
GEOLOGIC EVALUATION GULF
COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA
RELATION OF TRAVEL TIME ALONG
A VERTICAL FLOW PATH TO DEPTH
AT CANDIDATE DOME SITES

JOB NO. MV9766 FIGURE 14-17

pH, were measured at selected sites on streams in the vicinity of the dome (Figure 14-2). These data were integrated with groundwater data collected by LETCo and USGS, and with data previously collected by USGS.

Results of field measurements at surface sites around the dome indicate that surface waters are low in dissolved solids (Table 14-9). Conductances ranged between 24 and 205 micromhos per centimeter. The high range in conductance values may be significant. Additional investigation is needed to identify reasons for this variance. Gandl and Spiers (1980) indicate that surface water around the dome is mostly a sodium bicarbonate type, low in dissolved solids, and slightly acidic.

The chemical character of fresh water in the Miocene deposits in the vicinity of Richton Dome is similar to the chemical character of fresh water found regionally. The water is a sodium bicarbonate type, having low concentrations of total dissolved solids. Concentrations of dissolved constituents correlated well with those of regional well sites.

Saline water from the lower Miocene deposits at Site MRIH-11 is a sodium chloride type with a total dissolved-solids concentration of approximately 10,000 mg/l (10,000 ppm).

Saline waters at Site MRIH-11 in geologic deposits underlying the Miocene deposits are also similar to those encountered regionally. These waters are sodium chloride types, with total dissolved-solids concentrations varying from approximately 6,600 mg/l (6,600 ppm) in the Cook Mountain Formation to more than 100,000 mg/l (100,000 ppm) in the Wilcox Group. Concentrations of dissolved constituents in the water correlated well with those of regional well sites.

14.3.1.4 Relationship of Surface Water to Ground Water: Low flow of streams in the vicinity of Richton Dome, expressed as the 7-day, 2-year low flow, are indicators of hydrogeologic properties for the Hattiesburg Formation in that area. The Hattiesburg Formation is the dominant surficial geologic unit in the area.

Low flow of streams in the vicinity of the dome suggest that the average hydraulic properties of the Hattiesburg Formation in this area are relatively low and that local recharge is minimal. The 7-day, 2-year low flow for both Thompson Creek and Bogue Homo in the vicinity of Richton Dome is approximately 0.84 l/sec (0.03 ft^3/sec) per square mile of drainage area (Shows and others, 1966). This value is very low compared to that from streams in other portions of the study area.

14.3.1.5 Water and Aquifer Use: No appreciable surface-water withdrawals could be identified in the vicinity of Richton Dome.

There are two local concentrations of ground-water usage near the dome. The town of Richton, Mississippi, located 3 km (2 mi) southeast of the dome, and the Northeast Perry County Utility Association, located 5 km (3 mi) northeast of the dome, both obtain water supplies from Miocene deposits. Within the town of Richton there are two public supply wells. One well is completed at a depth of 201 meters (660 ft) and the other at a depth of 244 meters (736 ft). The average pumping rate of these wells is 25 l/sec (390 gal/min). One industrial well in Richton pumps 13 l/sec (200 gal/min) from a depth of 23 meters (77 ft). The Northeast Perry County Utility Association has a 158-meter (520-ft)-deep public supply well producing 11 l/sec (180 gal/min) (Callahan, 1975).

Other ground-water withdrawals are typical of a small farm, rural area, with numerous domestic and other low-yield [less than 1-l/sec (20-gal/min)] wells completed in deposits of Miocene age and younger.

There are no disposal wells located in the vicinity of Richton Dome but there are some wells located immediately outside the study area to the northwest and east of the dome (Figure 14-12).

14.3.2 CYPRESS CREEK DOME: Data for hydrologic analyses are available from several locations in the vicinity of Cypress Creek Dome (Figure 14-2). The number and configuration of geologic and hydrogeologic data-collection sites are similar to those near Richton Dome. One geologic data-collection site was located over the dome and another approximately 5 km (3 mi) north of the dome. A hydrogeologic data-collection site was located approximately 6 km (4 mi) south of the dome. Three sites were intended to collect data from an area near the dome, but not to fully characterize the dome.

Eight surface-water chemical and physical parameter-measuring sites were located around the dome. Numerous other chemical and physical ground-water parameter data available from USGS in the domal area were identified and retrieved from the USGS WATSTORE computer system.

14.3.2.1 Surface-Water Hydrology: Cypress Creek Dome is located in the Cypress Creek watershed, a tributary to Black Creek, which flows into the Pascagoula River (Figure 14-2). The watershed is located in Perry County and drains an area of 151 km^2 (58.4 mi^2).

Cypress Creek watershed is in the Piney Woods Physiographic Subprovince and it is characterized by gently rolling hills. The ground surface varies from 25 to 97 meters (83 to 320 ft) above MSL. The drainage pattern is predominantly dendritic with stream bed slopes varying from more than 5 m/km (27 ft/mi) in the headwaters to about 1 m/km (5.3 ft/mi) near the mouth.

Cypress Creek meanders through a flood plain that averages approximately 0.8 km (0.5 mi) in width. A depression over the domal area has formed a swampy area that retards flow in the upper reach of the stream. The stream bed slope through this reach is 1 m/km (5.3 ft/mi).

The major portion of the watershed is managed forestland of predominantly pine and mixed hardwoods. Less than 5 percent of the Cypress Creek watershed land area is under cultivation or pasture.

Mean annual precipitation for the Cypress Creek watershed is 1,524 mm (60 in). Average annual runoff is 533 mm (21 in).

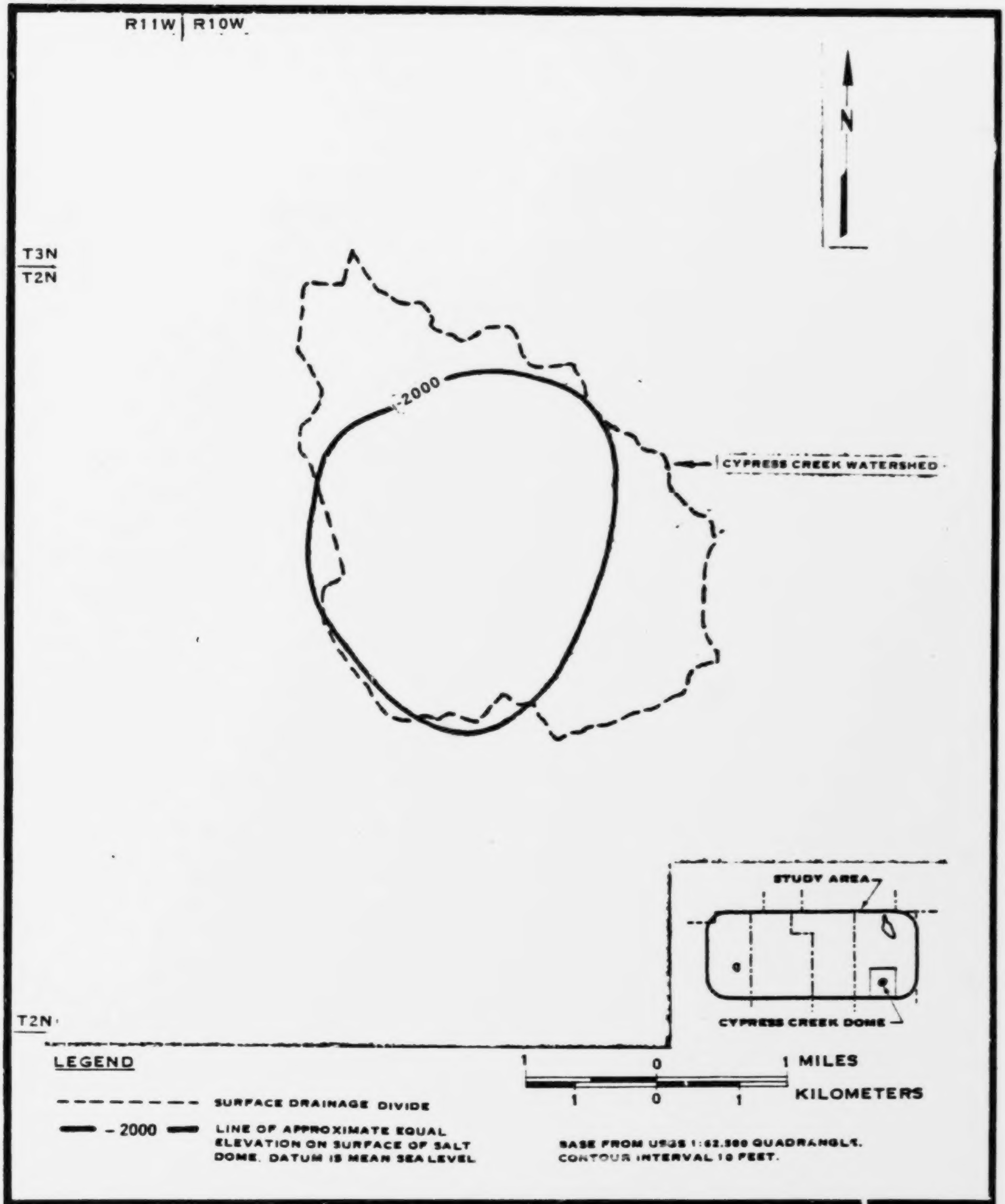
14.3.2.1.1 Domal Area Drainage - The topography over Cypress Creek Dome is gently rolling to hilly. Elevations at the dome vary from 55 to 82 meters (180 to 270 ft) above MSL.

The domal area is drained by the headwaters of Cypress Creek (Figure 14-18). The character of the site drainage is inconsistent with the regional dendritic pattern. A deranged drainage pattern with an upland swamp covers a depression in the central portion of the area.

14.3.2.1.2 Historical Floods - There are no published records of floods in the domal area. The one USGS station in the watershed, Cypress Creek near Janice, Mississippi (Station Number 02479155), is 14 km (9 mi) downstream from the dome (Figure 14-2). Stream flow records are available at this station for the period of October 1966 to the present. The maximum flood occurred on June 1, 1959. The maximum discharge for this flood was 645,696 l/sec (22,800 ft^3/sec), or approximately 12,376 l/sec (437 ft^3/sec) per square mile of drainage area. The corresponding stage was 43 meters (141.1 ft) above MSL (U.S. Geological Survey, 1978). This flood occurred prior to establishment of the stream gauging station.

14.3.2.1.3 Flood-Plain Delineation - General methodology involved in delineating the flood plain was the same as that used for Richton Dome. The flood analysis was made for Cypress Creek watershed upstream of the State Highway 29 bridge (Figure 14-18). This point is about 1.6 km (1 mi) downstream from the dome and it has a drainage area of 22 km^2 (8.5 mi^2). (For details regarding these computations, see the Mississippi Study Area Appendix.)

AF 12338A


R11W
R10W
N
T3N
T2N
-2000
CYPRESS CREEK WATERSHED
STUDY AREA
CYPRESS CREEK DOME
T2N
LEGEND
SURFACE DRAINAGE DIVIDE
- 2000
LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME. DATUM IS MEAN SEA LEVEL
1 0 1 MILES
1 0 1 KILOMETERS
BASE FROM USGS 1:62,500 QUADRANGLE.
CONTOUR INTERVAL 10 FEET.

PREPARED BSM DATE 8/21/
REVISED ________ DATE ______
REVISED ________ DATE ______
APPROVED DATE
T-1162-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

TOPOGRAPHY AND DRAINAGE
IN VICINITY OF
CYPRESS CREEK DOME

JOB NO. MV9600 FIGURE 14-18

BEST DOCUMENT AVAILABLE

Maximum flooding on streams crossing the dome would inundate about 456 hectares (1,128 acres), or approximately 44 percent, of the area defined by the surface projection of the -610-meter (-2,000-ft)-MSL salt dome contour. The area that would be inundated by a probable maximum flood is shown in Figure 14-19.

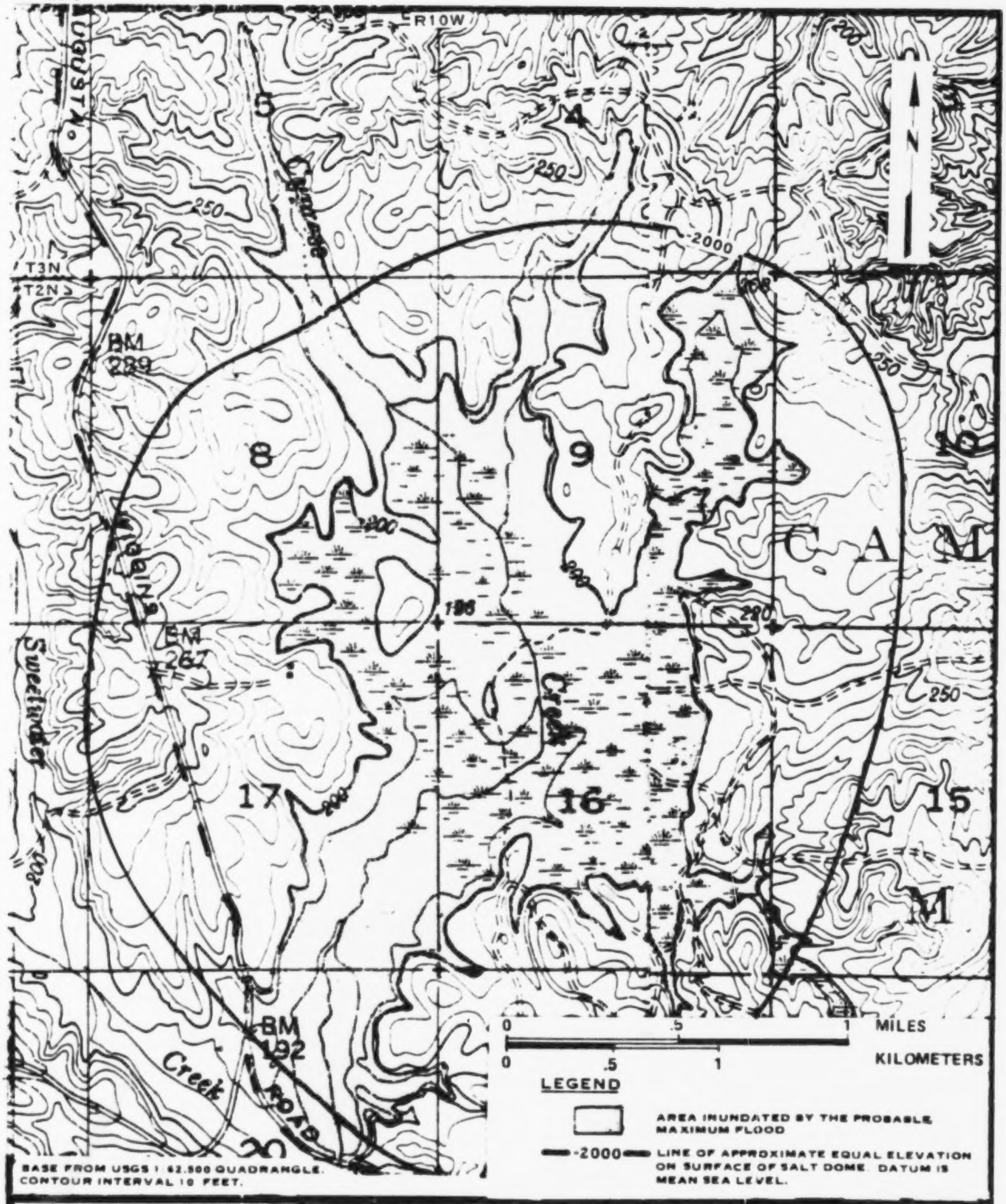
It is unlikely that the area inundated by the probable maximum flood would exceed that computed here. Parametric values included in the flood computations were estimated conservatively to produce high values of runoff and stream depths.

14.3.2.2 Ground-Water Hydrology: The sequence of geologic units at Cypress Creek Dome is similar to that which occurs regionally. Tertiary deposits include, in ascending order, the Midway, Wilcox, Claiborne, Jackson, and Vicksburg Groups and the Chickasawhay, Catahoula and Hattiesburg Formations. These are overlain by deposits of Quaternary age which include, in ascending order, the Citronelle Formation and Recent Alluvium. The Hattiesburg Formation is the basal unit directly overlying Cypress Creek Dome caprock.

14.3.2.2.1 Domal Area Hydrogeology - The aquifer system in the vicinity of Cypress Creek Dome is composed of the entire sequence of units of Tertiary and Quaternary age above the Midway Group (Figure 14-20), which forms the impermeable base for this aquifer system.

Two test wells were completed in the Sparta Formation for gathering hydrogeologic data. One test well was completed at

AF 12338A


R10W
T3N
T2N
5
4
8
9
10
17
16
15
BM 289
BM 267
BM 192
-2000
250
200
196
280
Sweetwater
Creek
Creek
ROAD
C A M
M
N
0 .5 1 MILES
0 .5 1 KILOMETERS
LEGEND
AREA INUNDATED BY THE PROBABLE MAXIMUM FLOOD
-2000 LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME. DATUM IS MEAN SEA LEVEL.

BASE FROM USGS 1:62,500 QUADRANGLE.
CONTOUR INTERVAL 10 FEET.

PREPARED RSM DATE 5-30-
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED DATE
T-1163-1

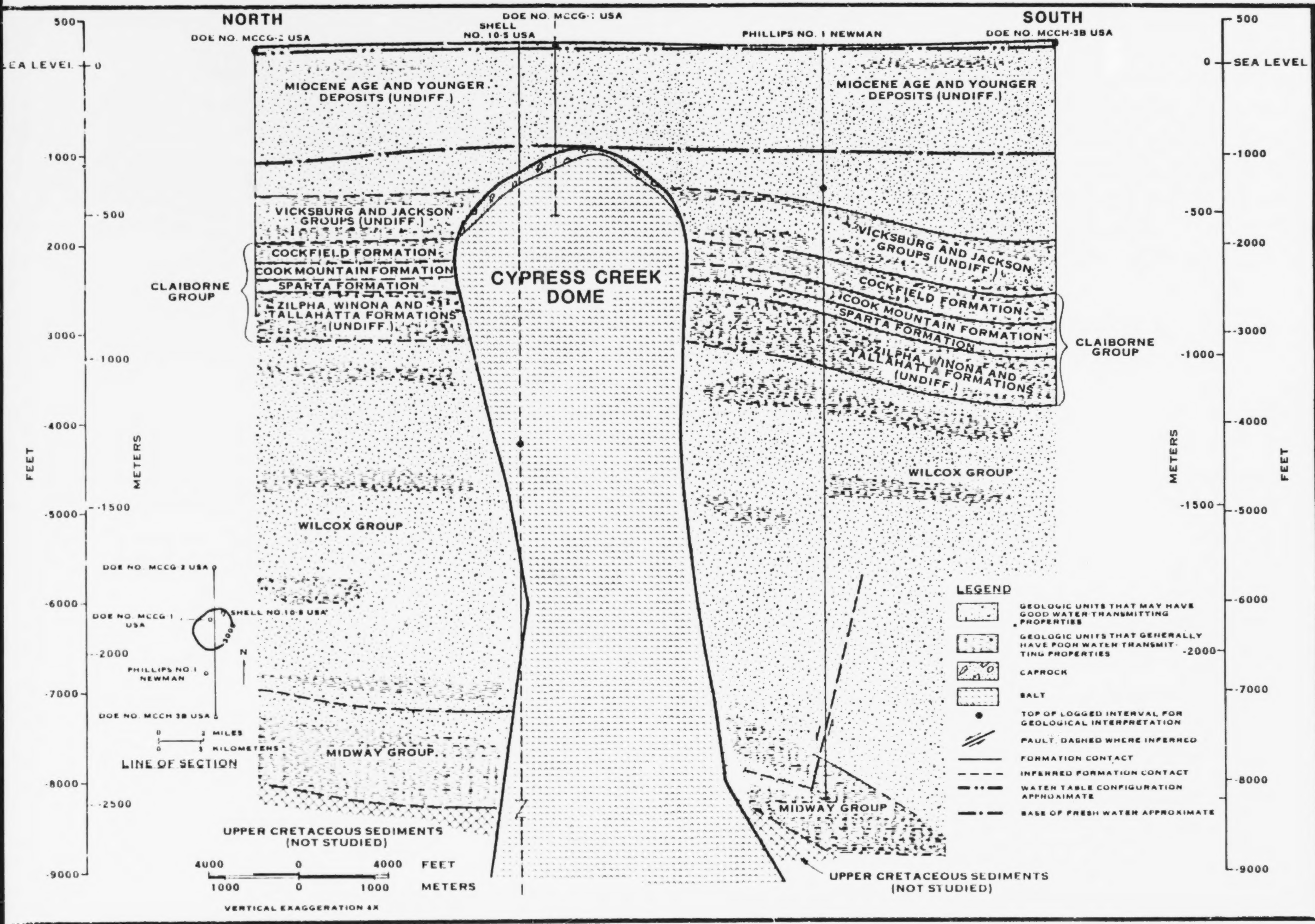
NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
CYPRESS CREEK DOMAL LOCATION SHOWING AREA INUNDATED BY PROBABLE MAXIMUM FLOODING
JOB NO MV5600 FIGURE 14-19

BEST DOCUMENT AVAILABLE

[redacted]

347


NORTH
SOUTH
DOE NO. MCCG-2 USA
SHELL NO. 10-5 USA
DOE NO. MCCG-1 USA
PHILLIPS NO. 1 NEWMAN
DOE NO. MCCH-3B USA
SEA LEVEL
FEET
METERS
500
0
-1000
-500
2000
3000
-1000
-4000
-5000
-1500
-6000
-2000
-7000
-8000
-2500
-9000
MIOCENE AGE AND YOUNGER DEPOSITS (UNDIFF.)
VICKSBURG AND JACKSON GROUPS (UNDIFF.)
COCKFIELD FORMATION
COOK MOUNTAIN FORMATION
SPARTA FORMATION
ZILPHA, WINONA AND TALLAHATTA FORMATIONS (UNDIFF.)
CLAIBORNE GROUP
CYPRESS CREEK DOME
WILCOX GROUP
MIDWAY GROUP
UPPER CRETACEOUS SEDIMENTS (NOT STUDIED)
DOE NO. MCCG-2 USA
DOE NO. MCCG-1 USA
SHELL NO. 10-5 USA
PHILLIPS NO. 1 NEWMAN
DOE NO. MCCH 3B USA
3000
N
0 2 MILES
0 3 KILOMETERS
LINE OF SECTION
4000 0 4000 FEET
1000 0 1000 METERS
VERTICAL EXAGGERATION 4X
LEGEND
GEOLOGIC UNITS THAT MAY HAVE GOOD WATER-TRANSMITTING PROPERTIES
GEOLOGIC UNITS THAT GENERALLY HAVE POOR WATER TRANSMITTING PROPERTIES
CAPROCK
SALT
TOP OF LOGGED INTERVAL FOR GEOLOGICAL INTERPRETATION
FAULT, DASHED WHERE INFERRED
FORMATION CONTACT
INFERRED FORMATION CONTACT
WATER TABLE CONFIGURATION APPROXIMATE
BASE OF FRESH WATER APPROXIMATE

MISSISSIPPI STUDY AREA

HYDROGEOLOGIC CROSS-SECTION THROUGH CYPRESS CREEK DOME

FIGURE 14-20

JOB NO. MV9600

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES

LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

PREPARED DATE 9/28/81
REVISED DATE
REVISED DATE
APPROVED RSM DATE 9/28/81

T-1918-1

BEST DOCUMENT AVAILABLE

Site MCCG-2 and the other at Site MCCH-3. Aquifer testing at Site MCCG-2 gave a hydraulic conductivity of 20 m/day (65 ft/day). Aquifer testing at site MCCH-3 gave a much lower hydraulic conductivity of 0.0003 m/day (0.001 ft/day). Water pumped during testing was saline at both sites. The total dissolved-solids content of water from the Sparta Formation was approximately 110,000 mg/l (110,000 ppm) at Site MCCG-2, and approximately 200,000 mg/l (200,000 ppm) at Site MCCH-3.

Selected data for hydrogeologic analyses were collected from the Cockfield Formation at Site MCCH-3. One test well was completed in the Cockfield Formation. Aquifer testing at this well gave a relatively low hydraulic conductivity of 0.006 m/day (0.02 ft/day). Water pumped during testing was saline, the total dissolved-solids content of the water being approximately 200,000 mg/l (220,000 ppm).

Four test wells for hydrogeologic data collection were completed in the Hattiesburg and Catahoula Formations. One test well was completed in the Catahoula Formation. This well was located at Site MCCH-3. Aquifer testing gave a hydraulic conductivity value of 3 m/day (10 ft/day). Water pumped during this test was saline, the total dissolved-solids content of the water being approximately 130,000 mg/l (130,000 ppm). Another test well at Site MCCH-3 was completed in the undifferentiated Hattiesburg-Catahoula unit. Aquifer testing of this zone gave a hydraulic conductivity of 15 m/day (50 ft/day). The total dissolved-solids content of the water was approximately 1,700 mg/l (1,700 ppm). Two test wells were completed in the

Hattiesburg Formation. One test well was completed at Site MCCG-2 and the other at Site MCCH-3. Aquifer testing gave a hydraulic conductivity value of 5 m/day (17 ft/day) at Site MCCG-2 and 61 m/day (200 ft/day) at Site MCCH-3. Water pumped during these tests was fresh, the total dissolved-solids content varying from 115 to 140 mg/l (115 to 140 ppm) between sites.

Two subregional hydraulic conductivity trends in the vicinity of the dome are apparent from the testing program. First, hydraulic conductivity of the Sparta Formation appears to decrease significantly south of Cypress Creek Dome. This decrease results in part from the considerably increased clay content in the Sparta Formation south of the dome. It may also be caused by increased compaction resulting from greater thicknesses of overburden to the south. Second, the hydraulic conductivity of the Hattiesburg Formation appears to increase to the south in the vicinity of the dome. This increase is caused primarily by a difference in lithology.

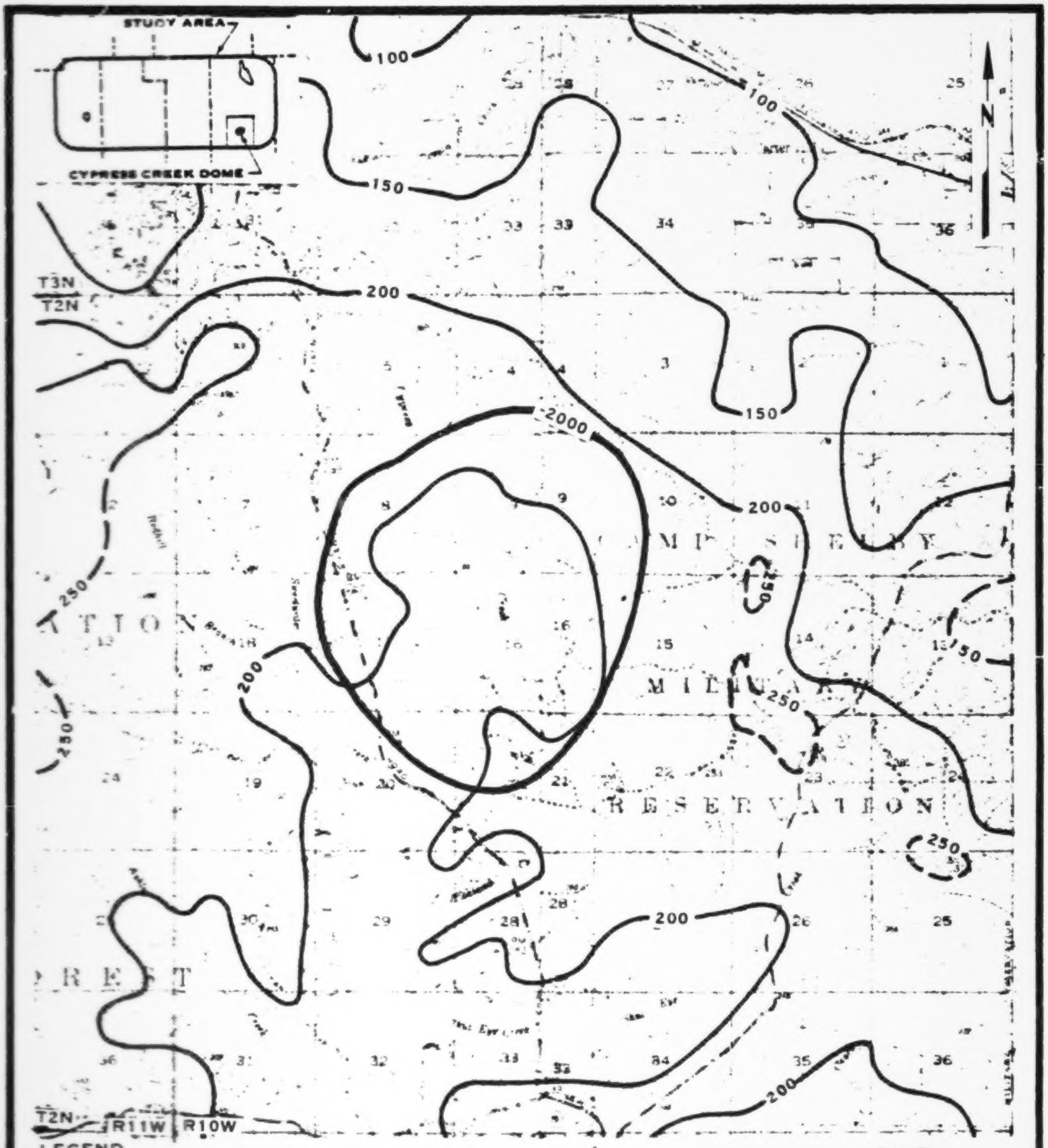
The caprock overlying Cypress Creek Dome was tested for hydraulic properties by completing a well at Site MCCG-1 (Table 14-7). Test results indicated a hydraulic conductivity of 0.10 m/day (0.36 ft/day). Water pumped during the test was saline, the total dissolved-solids content being approximately 16,500 mg/l (16,500 ppm).

Ground-water movement in the caprock is believed to be primarily through fractures, joints, and solution channels. Problems in maintaining water circulation during drilling operations at Site MCCG-1 in the upper portion of the caprock suggest that solution channels exist there and that secondary-porosity features are probable. Sixteen meters (fifty-two feet) of the upper caprock was grouted to facilitate ease of coring and was not hydrologically tested. Further investigation is needed to define the hydraulic properties of the upper portion of the caprock.

The hydraulic properties of the caprock at the caprock-salt interface also were investigated (Table 14-7). A drill-stem test was performed using straddle packers. This test gave a hydraulic conductivity of 0.002 m/day (0.008 ft/day).

A relatively permeable zone exists in the Miocene deposits just above the caprock at Cypress Creek Dome. This zone is approximately 70 meters (230 ft) thick with its base about 15 meters (50 ft) above the caprock surface. Wide permeability variations occur over short vertical distances in the Miocene deposits above this zone. It is estimated that the dome caprock is generally three or more orders of magnitude less permeable than that in the overlying permeable zone in the Miocene deposits.

Flow directions at shallow depths in the aquifer system [less than about 30 meters (100 ft)] in the vicinity of Cypress Creek Dome were determined from the shape of the water table (Figure 14-21). Water-table contours were drawn by considering altitudes of streams, as well as water levels in wells. Water-level information was obtained from topographic maps, shallow wells drilled by LETCo, and data supplied by USGS. Flows are generally from areas of high water-table elevations, under the


STUDY AREA
CYPRESS CREEK DOME
N
100
150
200
-2000
250
T3N
T2N
R11W
R10W
CAMP SHELBY
MILITARY
RESERVATION
FOREST

LEGEND

— 200 — WATER-TABLE CONTOUR. CONTOUR INTERVAL 50 FEET. DASHED WHERE APPROXIMATE. DATUM IS MEAN SEA LEVEL.

— -2000 — LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME. DATUM IS MEAN SEA LEVEL.

1 0 1 MILE

1 0 1 KILOMETER

BASE FROM USGS 1:62500 QUADRANGLE

CONTOUR INTERVAL 10 FEET.

PREPARED [illegible] DATE [illegible] REVISED ______ DATE ______ REVISED ______ DATE ______ APPROVED [illegible] DATE [illegible] T-1400-1	NATIONAL WASTE TERMINAL STORAGE PROGRAM GEOLOGIC EVALUATION GULF COAST SALT DOMES LAW ENGINEERING TESTING COMPANY MARIETTA GEORGIA	MISSISSIPPI STUDY AREA WATER TABLE IN VICINITY OF CYPRESS CREEK DOME JOB NO. MV9600 FIGURE 14-21

BEST DOCUMENT AVAILABLE

ridge surrounding the domal area on the west, north, and east, to areas of low elevations of the water table in the Cypress Creek and Leaf River valleys. The ridge area is a local recharge area. The Cypress Creek and Leaf River valleys are local discharge areas.

Horizontal flow directions deeper in the aquifer system were determined from the hydraulic gradient along Cross Section A-A' (Figure 14-8). The general slope of potentiometric surfaces at 244, 701, and 914 meters (800, 2,300, and 3,000 ft) below MSL are southerly in the vicinity of Cypress Creek Dome, indicating that flow at these elevations is southerly near the dome.

Vertical flow directions were determined from an analysis of the vertical distribution of environmental heads (Figure 14-8). Environmental heads at Site MCCH-3 south of the dome suggest that upward flow is occurring from the Sparta Formation through the Cockfield Formation and into the Catahoula Formation. The head distribution also suggests that downward flow is occurring in the Hattiesburg Formation at Site MCCH-3. The head distribution at Site MH-4 north of the dome suggests that upward flow is occurring at this site throughout the depth of the aquifer system.

The base of the fresh-water zone in the vicinity of the dome was identified (Figure 14-5). The fresh-water base is approximately -244 meters (-800 ft) MSL at Site MCCG-2 north of the dome, -274 meters (-900 ft) MSL at Site MCCG-1 over the dome and about -305 meters (-1,000 ft) MSL at Site MCCH-3 south of the dome. The dome appears to have little effect on the base of fresh water.

14.3.2.2.2 Ground-Water Flow Time Analysis - The natural route for ground-water flow in the vicinity of Cypress Creek Dome is southerly and upward. Horizontal ground-water movement in the vicinity of the dome is in a southerly direction at the 244-, 701-, and 914-meter (800-, 2,300-, and 3,000-ft)-elevations below MSL. Ground-water velocities are on the order of 7, 0.03, and 0.001 m/yr (22, 0.1, and 0.005 ft/yr), respectively, at Site MCCH-3 near the dome at these elevations. Environmental heads suggest that under natural conditions there is downward flow from the Hattiesburg Formation to the Catahoula Formation and that there is upward flow to the Catahoula Formation from underlying formations at Site MCCH-3. The Hattiesburg Formation is in a subregional recharge area at this site.

A report by Pacific Northwest Laboratories (1979) inspired Law Engineering to investigate average vertical ground-water flowtimes from various depths below the fresh-water base to the base of the fresh-water surface at Cypress Creek Dome. Vertical flow times, computed on the basis of available data and estimated parameters, varied between approximately 49,000 years from a point 152 meters (500 ft) to approximately 300,000 years from a point 530 meters (1,740 ft) below the base of fresh water (Figure 14-17). The vertical velocity averaged about 0.0002 m/yr (0.007 ft/yr). These results indicate that the estimated average vertical ground-water flow times are long and that significant differences in vertical flow times between Cypress Creek Dome and other candidate domes cannot be substantiated.

The flow analysis suggests that ground-water moves southerly and upward near Cypress Creek Dome at elevations below about -457 meters (-1,500 ft) MSL and above -914 meters (-3,000 ft) MSL. The vertical and horizontal velocity components are of about equal magnitude at -914 meters (-3,000 ft) MSL, while at -701 meters (-2,300 ft) MSL the vertical velocity is about one order of magnitude greater than the horizontal velocity. This is in contrast to Richton Dome, where the horizontal velocities dominate the flow patterns at these elevations.

The geologic formations dip sharply into the Perry Basin south of Cypress Creek Dome. The Perry Basin, a geologic feature south of Cypress Creek Dome, probably retards horizontal flow in this area. (Chapter 12 describes the Perry Basin.)

14.3.2.3 Water Chemistry: The chemical composition of water in the vicinity of Cypress Creek Dome was investigated. Field parameters of water temperature, dissolved oxygen, conductance, and pH were measured at selected sites on streams in the vicinity of the dome (Figure 14-2). These data were integrated with ground-water data collected by LETCo and USGS and data previously collected by USGS.

Results of field measurements at surface sites around the dome indicate that surface waters are low in total dissolved-solids content (Table 14-8). No anomalies were observed in the data. Conductances ranged between 17 and 50 micromhos per centimeter. These data compare favorably with data collected by the USGS at a stream gauging station located on Cypress Creek near

BEST DOCUMENT AVAILABLE

TABLE 14-8
SUMMARY OF FIELD MEASUREMENTS MADE ON STREAMS IN VICINITY OF CANDIDATE SALT DOMES

STREAM NAME	STATION NO.[1]	DATE	TEMPERATURE (°C)	DISSOLVED OXYGEN (mg/l)	CONDUCTANCE (µmhos/cm)	pH (S.U
			RICHTON SALT DOME			
Buck Creek	1	4/24/78	19.5	8.5	205	5.0
Bogue Homo	2	"	20.5	9.3	170	5.5
Hatter Branch Trib.	3	"	17.5	6.0	40	5.9
Beaver Dam Creek	4	"	20.05	8.8	25	6.2
Pine Log Branch	5	"	19.5	5.5	40	5.1
Thompson Creek	6	"	16.5	9.5	46	-
Little Creek	7	"	17.5	-	22	-
Bogue Homo	8	"	20.0	-	165	-
Mill Creek	9	"	18.5	8.8	47	-
Fox Branch	10	"	24.0	-	38	-
Little Creek	11	"	18.0	-	34	-
Mike Branch	12	4/25/78	15.5	-	24	-
Thick Branch	13	"	16.0	7.9	25	-
Thompson Creek Trib.	14	"	17.5	7.1	26	-
Thompson Creek	15	"	16.0	7.8	41	-
Thompson Creek Trib. (S1 - Dome thru Richton)	16	"	17.0	6.8	100	-
Fire Branch	17	"	16.5	6.0	37	-
Thompson Creek Trib.	18	"	16.5	7.9	25	-
Thompson Creek	19	"	17.5	8.7	71	-
Mill Creek	20	"	17.0	9.0	29	-
Bogue Homo	21	"	19.0	8.6	140	-
Nicholson Bridge	22	"	17.0	-	34	-
Beaty Branch	23	"	19.5	5.6	36	-
Bear Branch	24	"	17.0	8.1	44	-
			CYPRESS CREEK SALT DOME			
Cypress Creek	1	4/25/78	20.8	6.5	25	-
[illegible] Creek	2	"	17.5	-	17	-
Cypress Creek	3	"	17.5	9.8	18	-
[illegible] Creek	4	"	19.0	8.5	18	-
[illegible] Creek	[illegible]	"	17.0	[illegible]	36	-
[illegible] Trib. to Leaf River	[illegible]	"	17.0	-	29	-
[illegible] Creek	[illegible]	"	17.[illegible]	9.[illegible]	50	-
[illegible] Branch	8	"	17.4	-	41	-
			LAMPTON SALT DOME			
Upper Little Creek	1	4/26/78	16.2	9.6	29	
Upper Little Creek	2	"	15.0	-	29	
Upper Little Creek Trib.	3	"	14.5	9.1	24	
Upper Little Creek Trib.	4	"	14.0	-	[illegible]	
Upper Little Creek	[illegible]	"	16.5	9.1	[illegible]	
[illegible] Creek	[illegible]	"	15.0	-	46	
Lower Little Creek Trib.	[illegible]	"	14.5	[illegible]	34	
Lower Little Creek	[illegible]	"	16.5		22	
[illegible] Creek Trib.	[illegible]	"	16.5		22	
[illegible] Creek	10	"	18.0	[illegible]	22	
Lower Little Creek	11	"	17.[illegible]		22	

---

[1] SEE FIGURE 14.2 FOR LOCATION

[redacted]

356

Janice, Mississippi (Figure 14-2). Chemical analyses by the USGS indicate that surface water around the dome is a sodium bicarbonate type, low in dissolved solids, and slightly acidic (Gandl and Spiers, 1980).

The chemical character of fresh water in the upper Miocene deposits in the vicinity of Cypress Creek Dome varies from south to northeast of the dome. South of the dome the water is a sodium bicarbonate type having low concentrations of dissolved solids. This water is very similar to the regional waters of Miocene deposits. Northeast of the dome the water is a sodium chloride type having higher concentrations of dissolved solids than commonly encountered in fresh water in the study area. It is not clearly understood why fresh waters in upper Miocene deposits northeast of the dome are anomalous in their chemistry. The flow direction in these aquifers in this area is northeast and it is controlled by the Leaf River (Figure 14-7). It is possible that the salt dome is contributing to the anomalous chemistry of the waters in Miocene deposits in this region. There is evidence of subsidence over the dome (see Chapter 13). This subsidence could have been caused by salt dissolution. Other explanations, however, could also be advanced. For example, it is possible that old oil test wells in the area, if inadequately plugged, could be transmitting water from deeper saline formations upward to Miocene deposits. It is also possible that improper disposal of brine wastes may have occurred in the area, resulting in the addition of sodium chloride to the natural water. Additional investigation is needed to explain the anomaly.

Saline waters from the lower Miocene deposits at Site MCCH-3 are a sodium chloride type with total dissolved-solids concentrations ranging between 1,000 and 130,000 mg/l (1,000 and 130,000 ppm).

Saline waters at Site MCCH-3 in geologic deposits underlying the Miocene deposits may be characterized as sodium chloride types, with total dissolved-solids concentrations exceeding 200,000 mg/l (200,000 ppm). Dissolved-solids concentrations in waters around the dome are generally higher than those at regional sites, yet they are present in similar proportions.

14.3.2.4 Relationship of Surface Water to Ground Water: Low flow of streams in the vicinity of Cypress Creek Dome, expressed as the 7-day, 2-year low flow, is an indicator of hydrogeologic properties for the Citronelle Formation in that area. The Citronelle Formation is the principal surficial geologic unit in the area.

Low flows of streams in the vicinity of the dome suggest that the hydraulic properties of this formation are relatively high and that local recharge to this formation is also high. The 7-day, 2-year low flow for Black Creek, 18 km (11 mi) upstream from its confluence with Cypress Creek, is approximately 5.7 l/sec (0.2 ft^3/sec) per square mile of drainage area (Taylor and others, 1968). This is the closest point to Cypress Creek for which low-flow data were available and is probably representative of dry weather flows for Cypress Creek.

14.3.2.5 Water and Aquifer Use: Water and aquifer use in the vicinity of Cypress Creek Dome are minimal.

No appreciable surface-water withdrawals could be identified in the vicinity of the dome.

Only one concentration of ground-water usage occurs in the vicinity of the dome. The town of New Augusta, Mississippi, located 6.7 km (4.2 mi) northwest of the dome, obtains its water supply from six public supply wells completed in lower deposits of Miocene age. These wells range in depth 220 to 332 meters (721 to 1,090 ft). They produce water at rates from 1 to 13 l/sec (20 to 200 gal/min) (Callahan, 1975; Shows and others, 1966). Four of the six wells flow naturally.

Domestic and other low-yield [less than 1 l/sec (20 gal/min)] wells are sparsely located along county roads in the area. These wells are completed in deposits of Miocene age and younger.

Shell Oil Company operates one injection disposal well on the northwest flank of the Cypress Creek Dome. Saline water is injected into the Wilcox Group at depths of 1,643 to 1,647 meters (5,390 to 5,405 ft), 1,650 to 1,653 meters (5,413 to 5,425 ft) and 1,656 to 1,661 meters (5,432 to 5,450 ft). The average injection rate for 1979 was 0.003 l/sec (2 bbl/day) according to records of the Mississippi State Oil and Gas Board.

14.3.3 LAMPTON DOME: Data available for hydrologic analyses in the vicinity of Lampton Dome are sparse (Figure 14-2). Chemical and physical parameter-measuring sites for surface waters were located at eleven points around the dome. Chemical and physical ground-water parameter data, available from the USGS in the domal area, were identified and retreived from the USGS WATSTORE system.

Near-domal data-collection sites were not drilled in the vicinity of Lampton Dome. Data collection efforts were curtailed in the fall of 1979 by direction from ONWI (Law Engineering Testing Company, 1979). The hydrogeologic data base at that time was minimal.

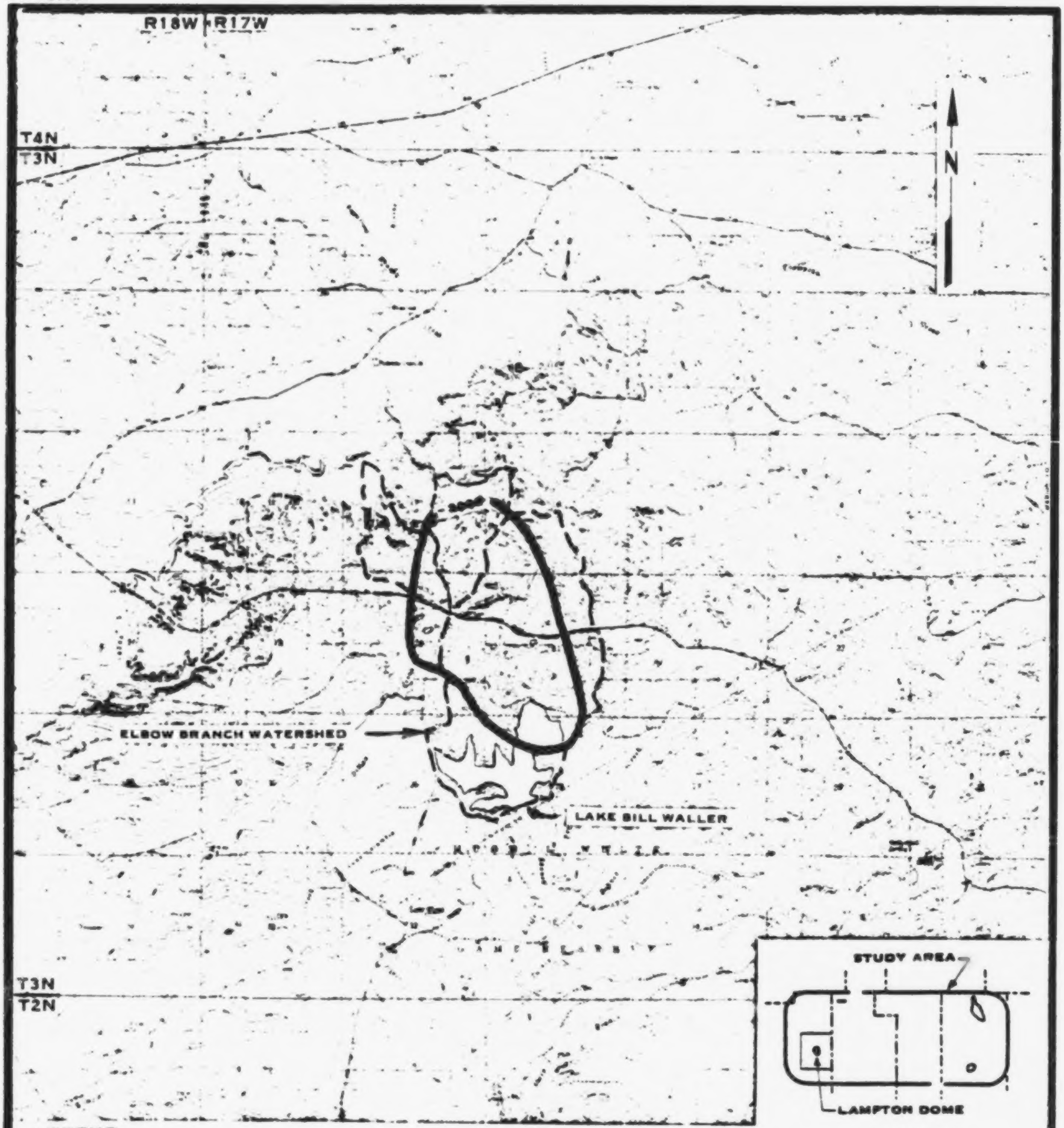
14.3.3.1 Surface-Water Hydrology: Lampton Dome is located along the drainage divide between Upper and Lower Little Creek, two tributaries to the Pearl River (Figure 14-22). Those watersheds drain 285 and 337 km^2 (110 and 130 mi^2), respectively.

Upper and Lower Little Creek watersheds are in the Piney Woods Physiographic Subprovince and they are characterized by gently rolling to hilly topography. Elevations vary from 122 meters (400 ft) above MSL in the headwaters area to 37 meters (120 ft) above MSL near the mouth. The drainage pattern is predominantly dendritic with stream bed slopes ranging from more than 4 m/km (20 ft/mi) in the headwaters to 0.6 m/km (3 ft/mi) near the mouth.

Mean annual precipitation for the Upper and Lower Little Creek watersheds is approximately 1,499 mm (59 in).

14.3.3.1.1 Domal Area Drainage - The topography overlying Lampton Dome is gently rolling to hilly. An east-west trending topographic divide separates the site into approximately two equal

AF 12338A


R18W
R17W
T4N
T3N
N
ELBOW BRANCH WATERSHED
-2000
LAKE BILL WALLER
T3N
T2N
STUDY AREA
LAMPTON DOME

LEGEND

- - - - - - - SURFACE DRAINAGE DIVIDE.

—— -2000 —— LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME. DATUM IS MEAN SEA LEVEL.

1 0 1 MILES

1 0 1 KILOMETERS

BASE FROM USGS 1:24,000 QUADRANGLE.
CONTOUR INTERVAL 10 FEET.

PREPARED RSM DATE 5-30-80
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED [illegible] DATE 8/4/80
T-1165-2

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA

TOPOGRAPHY AND DRAINAGE IN VICINITY OF LAMPTON DOME

JOB NO. MV9600 FIGURE 14-22

361

BEST DOCUMENT AVAILABLE

parts. Topography north of this divide is considerably more rugged than south of the divide. Elevations vary from 112 meters (367 ft) above MSL near the center of the site to 58 meters (190 ft) above MSL at the northeast corner.

The domal area is drained radially by several minor tributaries to Upper and Lower Little Creeks (Figure 14-22). The most significant flood potential at the site is from rises in lake stages on Lake Bill Waller, and from backwater effects on Elbow Branch created by the presence of the lake.

14.3.3.1.2 Historical Floods - There are no published records of floods in the domal area and no USGS gauging stations in the Upper or Lower Little Creek watersheds. The nearest gauging station, Pearl River near Columbia, Mississippi (Station Number 02489000), is located on the Pearl River 20 km (12.5 mi) upstream from the mouth of Upper Little Creek (Figure 14-2). Stream flow records are available at this station for the periods August, 1928 to September, 1954, and January, 1972 to the present. The maximum flood recorded at this gauge occurred on April 9, 1938. The maximum discharge for this flood was 2,056,032 l/sec (72,600 ft^3/sec) or approximately 368 l/sec (13 ft^3/sec) per square mile of drainage area. The maximum flood stage was 43 meters (142 ft) above mean sea level (U. S. Geological Survey, 1978).

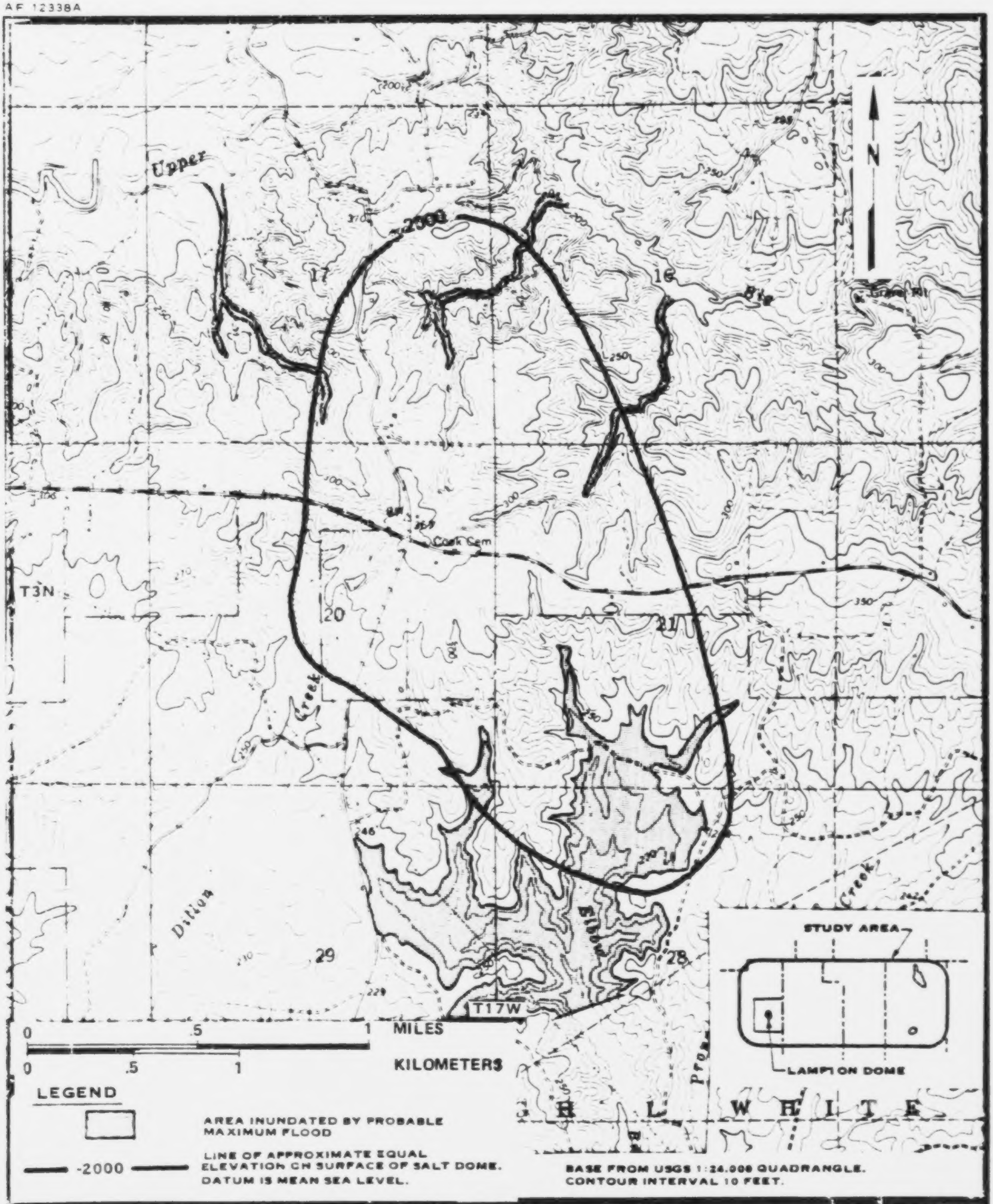
14.3.3.1.3 Flood-Plain Delineation - General methodology involved in delineation of the flood plain was the same as that used at Richton Dome. The flood analysis upstream of the Lake

Bill Waller dam was made for Elbow Branch, a second-order tributary to Lower Little Creek (Figure 14-22). Details regarding these computations are presented in the Mississippi Study Area Appendix. Maximum flooding on streams overlying the dome would inundate about 43 hectares (107 acres), or approximately 10 percent, of the projected area above the -610-meter (-2,000-ft)-MSL salt dome contour. This represents the probable maximum flood over the Elbow Branch watershed above the Lake Bill Waller dam and over the other minor streams, as is shown in Figure 14-23. This area includes backwater and storage effects of Lake Bill Waller on Elbow Branch.

It is unlikely that the area inundated by the probable maximum flood would exceed that computed here. Parametric values included in the flood computations were estimated conservatively to produce high values of runoff and stream depths.

14.3.3.2 Ground-water Hydrology: The sequence of hydrogeologic units surrounding Lampton Dome is similar to that which occurs regionally. Units of Tertiary age include, in ascending order, the Midway, Wilcox, Claiborne, Jackson, and Vicksburg Groups and the Chickasawhay, Catahoula and Hattiesburg Formations. These are overlain by units of Quaternary age which include, in ascending order, the Citronelle Formation and Recent Alluvium. The Chickasawhay Formation immediately overlies the Lampton Dome caprock.

[redacted]


AF 12338A
Upper
-2000
17
16
Big
T3N
20
21
Creek
Dillon
29
28
T17W
Cook Cem
350
300
250
0
.5
1
MILES
0
.5
1
KILOMETERS
STUDY AREA
LAMPTON DOME
H L WHITE
LEGEND
AREA INUNDATED BY PROBABLE MAXIMUM FLOOD
-2000
LINE OF APPROXIMATE EQUAL ELEVATION ON SURFACE OF SALT DOME. DATUM IS MEAN SEA LEVEL.
BASE FROM USGS 1:24,000 QUADRANGLE.
CONTOUR INTERVAL 10 FEET.

PREPARED RSM DATE 5-30-80
REVISED ______ DATE ______
REVISED ______ DATE ______
APPROVED ______ DATE ______
T-11_6-2

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA GEORGIA

MISSISSIPPI STUDY AREA
LAMPTON DOMAL LOCATION
SHOWING AREA INUNDATED BY
PROBABLE MAXIMUM FLOODING

JOB NO. MV9600 FIGURE 14-23

BEST DOCUMENT AVAILABLE

364

14.3.3.2.1 Domal Area Hydrogeology - The aquifer system of interest in the vicinity of Lampton Dome is composed of the entire thickness of units of Tertiary and Quaternary age above the Midway Group (Figure 14-24). The Midway Group forms the base for this aquifer system.

Test wells were completed in the Wilcox Group and in the Cook Mountain and Hattiesburg Formations at Site MH-8. Testing was conducted in each of these geologic units. Test results for the Wilcox Group indicated a hydraulic conductivity of 3.6 m/day (12.2 ft/day). Water pumped during testing was saline, with a total dissolved-solids content of approximately 43,000 mg/l (43,000 ppm). Aquifer testing in the Cook Mountain Formation gave a hydraulic conductivity of 2 m/day (6 ft/day). Water pumped from the Cook Mountain Formation was also saline, the total dissolved-solids content being approximately 36,000 mg/l (36,000 ppm). Testing in the Hattiesburg Formation gave a hydraulic conductivity of 44 m/day (145 ft/day). Water pumped during testing was fresh, the total dissolved-solids content being approximately 140 mg/l (140 ppm). Site MH-8 is the nearest test site for which hydrogeologic data are available. No test sites were drilled in the vicinity of Lampton Dome for collection of near-domal hydrogeologic data.

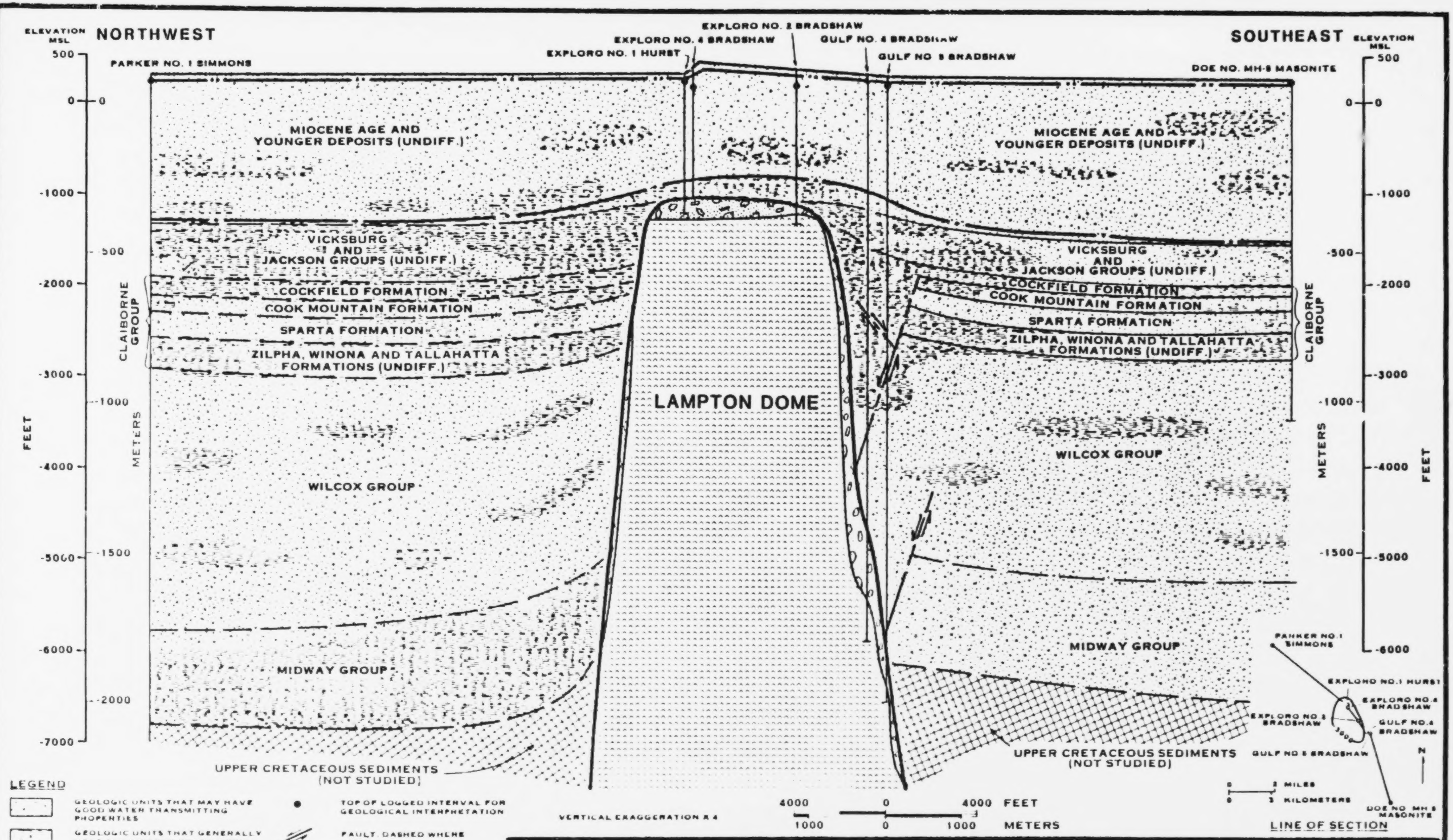
The base of fresh water is approximately -353 meters (-1,160 ft) MSL northwest of the dome at Parker Drilling, Simmons No. 1 well. The base rises to -244 meters (-800 ft) MSL over the dome at Exploro Corporation, Bradshaw No. 7 well, and falls to -482 meters (-1,580 ft) MSL southeast of the dome at Test Site MH-8. (See Figure 13-27 for well locations.)

Results of testing at Site MH-8 indicate that hydraulic properties of hydrogeologic units south of the dome are similar to those which occur regionally.

14.3.3.2.2 Ground-Water Flow Time Analysis - A report by Pacific Northwest Laboratories (1979) inspired Law Engineering to investigate estimated average ground-water flow times from various depths below the fresh-water base to the base of the fresh-water surface at Lampton Dome. Vertical flow times, computed on the basis of available data and estimated parameters, varied between approximately 63,000 years from a point 152 meters (500 ft), to approximately 419,000 years from a point 555 meters (1,820 ft) below the base of fresh water (Figure 14-17). The vertical velocity averaged about 0.002 m/yr (0.006 ft/yr). These results indicate that the estimated average vertical ground-water flow times are long and that significant differences in vertical flow times between Lampton Dome and other candidate domes cannot be substantiated.

Insufficient data were collected at Lampton Dome to investigate horizontal flow conditions. Natural flow conditions have been altered considerably in the area of the dome in response to injection stresses.

14.3.3.3 Water Chemistry: The chemical composition of water in the vicinity of Lampton Dome was described to the extent possible with the limited data. Field parameters of water temperature, dissolved oxygen, conductance, and pH were measured at selected sites on streams in the vicinity of the dome (Figure 14-2).


ELEVATION MSL
NORTHWEST
SOUTHEAST
ELEVATION MSL
EXPLORO NO. 2 BRADSHAW
EXPLORO NO. 4 BRADSHAW
GULF NO. 4 BRADSHAW
EXPLORO NO. 1 HURST
GULF NO 5 BRADSHAW
PARKER NO. 1 SIMMONS
DOE NO. MH-5 MASONITE
500
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
FEET
METERS
-500
-1000
-1500
-2000
CLAIBORNE GROUP
MIOCENE AGE AND YOUNGER DEPOSITS (UNDIFF.)
VICKSBURG AND JACKSON GROUPS (UNDIFF.)
COCKFIELD FORMATION
COOK MOUNTAIN FORMATION
SPARTA FORMATION
ZILPHA, WINONA AND TALLAHATTA FORMATIONS (UNDIFF.)
LAMPTON DOME
WILCOX GROUP
MIDWAY GROUP
UPPER CRETACEOUS SEDIMENTS (NOT STUDIED)
PARKER NO.1 SIMMONS
EXPLORO NO.1 HURST
EXPLORO NO.4 BRADSHAW
EXPLORO NO.2 BRADSHAW
GULF NO.4 BRADSHAW
GULF NO 5 BRADSHAW
DOE NO MH 5 MASONITE
N
0 2 MILES
0 3 KILOMETERS
LINE OF SECTION
VERTICAL EXAGGERATION X 4
4000 0 4000 FEET
1000 0 1000 METERS

LEGEND

⬚	GEOLOGIC UNITS THAT MAY HAVE GOOD WATER TRANSMITTING PROPERTIES
⬚	GEOLOGIC UNITS THAT GENERALLY HAVE POOR WATER TRANSMITTING PROPERTIES
⬚	CAPROCK
⬚	SALT
●	TOP OF LOGGED INTERVAL FOR GEOLOGICAL INTERPRETATION
⇗	FAULT, DASHED WHERE INFERRED
——	FORMATION CONTACT
– – –	INFERRED FORMATION CONTACT
—··—	WATER TABLE CONFIGURATION (APPROXIMATE)
—·—	BASE OF FRESH WATER (APPROXIMATE)

PREPARED ERR DATE 9/28/81
REVISED DATE
REVISED DATE
APPROVED RSM DATE 9/28/81
T-1167-1

NATIONAL WASTE TERMINAL STORAGE PROGRAM
GEOLOGIC EVALUATION GULF COAST SALT DOMES
LAW ENGINEERING TESTING COMPANY
MARIETTA, GEORGIA

MISSISSIPPI STUDY AREA

HYDROGEOLOGIC CROSS SECTION THROUGH LAMPTON DOME

JOB NO MV9600

FIGURE 14-24

367

BEST DOCUMENT AVAILABLE

These data were integrated with ground-water chemical data previously collected by USGS.

Results of field measurements at surface sites around the dome indicate that surface waters are low in dissolved solids (Table 14-9). No anomalies were observed in the data. Conductances range between 20 and 38 micromhos per centimeter. Chemical analyses of surface water collected by USGS indicate that surface water in the vicinity of the dome is a dilute, slightly acidic, nondescript type having similar concentrations of several dissolved constituents (Gandl and Spiers, 1980).

Ground-water chemical data in the vicinity of Lampton Dome were available from one USGS well site. Water sampled from this well was from Miocene deposits. Water analyses indicated that the water was a sodium bicarbonate type, with dilute concentrations of dissolved solids similar to that found regionally in deposits of Miocene age.

14.3.3.4 Relationship of Surface Water to Ground Water: Low flow of streams in the vicinity of Lampton Dome, expressed as the 7-day, 2-year low flow, is an indicator of hydrogeologic properties for the Hattiesburg Formation in that area. This formation is the principal surficial geologic unit in the area.

Low flow for streams in the vicinity of the dome suggests that the hydraulic properties of the Hattiesburg Formation in this area are relatively high and that local recharge is also high. The 7-day, 2-year low flow for both Upper Little Creek and Lower Little Creek in the vicinity of Lampton Dome is approximately 11.3 l/sec (0.4 ft^3/sec) per square mile of drainage area (Taylor and others, 1968). This value is high compared to streams throughout most of the study area.

14.3.3.5 Water and Aquifer Use: Water and aquifer use in the study area of Lampton Dome is minimal.

Surface-water usage is limited to recreational lakes. Lake Columbia and Lake Watts are both within 3 km (2 mi) of the dome. Lake Bill Waller is located over the southern portion of the dome.

There is one local concentration of ground-water usage near the dome. The Hub Water Authority, located 7.7 km (4.8 mi) southwest of the dome, has one well 313 meters (1,028 ft) deep that withdraws water from deposits of lower Miocene age. This well pumps 7 l/sec (200 gal/min) (Callahan, 1975).

Domestic and other low-yield [less than 1 l/sec (20 gal/min)] wells are sparsely located along county roads in the area. These wells are completed in sands and gravels of Miocene age, and in overlying deposits.

There are no deep injection wells within the study area of Lampton Dome.

14.4 HYDROLOGIC CHARACTERIZATION SUMMARY OF THE MISSISSIPPI STUDY AREA

The surface and subsurface hydrology of the study area and at selected domes was defined. Data used in this investigation came from a compilation of existing information and from a field data-collection program.

The study area lies within the Pascagoula and Pearl River watersheds. Richton and Cypress Creek Domes are located in the Pascagoula River watershed, and Lampton Dome is located in the Pearl River watershed.

Discharge occurs to major streams from near-surface deposits. This ground-water discharge to streams is greatest in the western portion of the study area. It decreases to the east and it is least in the northeast corner of the study area.

Surface water of suitable chemical quality is available for most uses. Water used from surface sources is generally for industrial supplies, with largest withdrawals occurring along tributaries of the Pascagoula River near Hattiesburg.

Areas of recharge to the aquifer system were identified. In general, recharge to deposits of Tertiary age occurs north of the study area in areas where these deposits are exposed at the surface and can be replenished by rainfall. Recharge to surficial deposits of Tertiary and Quaternary age in the study area occurs directly from rainfall.

Aquifers with good and poor water-transmitting properties in the study area were identified. The Wilcox Group and the Hattiesburg, Catahoula, and Citronelle Formations are considered to have good water-transmitting properties. The Midway Group, the Zilpha, Winona, and Tallahatta Formations and the combined Vicksburg and Jackson Groups are considered to have poor water-transmitting properties. The Kosciusko (Sparta) and Cook Mountain Formations generally have poor water-transmitting properties but locally may have good water-transmitting properties. The Cockfield Formation had poor water-transmitting properties at the one site where it was tested.

The aquifer system is used for water supply and brine waste disposal. Largest withdrawals of ground water are centered in the Hattiesburg area. Deposits of Miocene age are the source for this ground water. The heaviest concentrations of disposal wells are in the Baxterville Oil Field in Lamar County and the Hub Oil Field in Marion County. Most disposal wells in these fields inject brine into the Cook Mountain Formation.

Ground-water flow directions and velocities were defined. Flows at shallow depths in the aquifer system (depths not exceeding about 30 meters (100 ft) are generally from areas of high elevations of the water table under ridges to areas of low elevations of the water table in stream valleys. Horizontal flow directions at greater depths are generally southerly and vertical flows are generally upward in areas that have not been altered by injection stresses from disposal wells. Flow velocities average about 3 m/yr (10 ft/yr) in the Catahoula Formation and 2 m/yr (7 ft/yr) in the Upper Wilcox Group in these areas.

Ground-water flow has been altered by the injection of fluids into the aquifer system. Fluids are injected into the saline zone of the aquifer system at elevations generally below 701 meters (2,300 ft) MSL. Flows in the Claiborne Group in the southwest and western parts of the study area have been most affected by the injection stresses. Horizontal flows are radially away from a potentiometric high area in the southwest which has been created by injection stresses. Vertical flows in the southwest and west are upward from injection zones toward the fresh-water zone and also downward into the deeper saline water zone.

The chemical character of ground water changes with depth. Fresh water in shallow surficial deposits is mostly a calcium bicarbonate type. Fresh water in deposits of Miocene age is generally a dilute sodium bicarbonate type. Saline water may be characterized as a sodium chloride type, with dissolved solids and salinity generally increasing with depth. The interface between fresh and saline water occurs between elevations of 122 and 488 meters (400 and 1,600 ft) below MSL in the study area. Depth to saline water is greatest in the southwestern part of the study area and is least in the northeast part of the area. This interface is situated high in deposits of Miocene age in the vicinity of Richton and Cypress Creek Domes. The interface is situated near the base of the Miocene deposits elsewhere.

Conductances of surface waters in the vicinity of Richton Dome varied over a considerably wider range than those at either Cypress Creek or Lampton Domes. Conductances at Richton Dome vary between 22 and 205 micromhos per centimeter. Conductances at Cypress Creek Dome range between 17 and 50 micromhos per centimeter. At Lampton Dome, conductances range between 20 and 38 micromhos per centimeter. Further investigation is needed to identify the significance of the variability in surface-water conductance at Richton Dome.

Aquifer testing at Richton Dome uncovered several localized hydrogeologic trends. First, the hydraulic conductivity of the

Hattiesburg Formation appears to increase from north to south in the vicinity of the dome. This trend is caused primarily by differences in lithology. Second, the hydraulic conductivity of the Wilcox Group north of the dome appears to be less than that southwest of the dome. This change is also caused primarily by lithologic differences. Third, aquifer testing of the caprock overlying Richton Dome indicates that the caprock has fair water-transmitting properties, that near the caprock-salt interface it has very poor water-transmitting properties, and that there is probably hydraulic communication between the caprock and the overlying Hattiesburg Formation.

Hydrogeologic trends were identified from aquifer testing at Cypress Creek Dome. First, the hydraulic conductivity of the Kosciusko (Sparta) Formation appears to decrease significantly south of the dome. This decrease is caused in part by increased clay content in the Sparta Formation south of the dome. It may also be caused by increased compaction resulting from greater thicknesses of overburden to the south. Second, the hydraulic conductivity of the Hattiesburg Formation appears to increase to the south in the vicinity of the dome. This increase is caused primarily by differences in lithology. Third, the upper portion of the caprock overlying Cypress Creek Dome appears to have good water-transmitting properties, while the lower portion has poor water-transmitting properties.

The fresh-water base remains relatively high in the Miocene deposits south of Richton Dome in the area between Richton and Cypress Creek Domes. Several reasons can be hypothesized but none can be proven. Further investigation is needed to explain the reasons for the high fresh-water base south of Richton Dome.

A chemical anomaly occurs in the fresh-water zone in deposits of Miocene age north of Cypress Creek Dome between the dome and the Leaf River. Total dissolved-solids concentration of the ground water in this area is approximately 500 mg/l (500 ppm). The water can be described as a sodium chloride type. Total dissolved-solids content of the ground water in surrounding areas is generally less than 200 mg/l (200 ppm) and it can be described as a sodium bicarbonate type. Additional investigations are needed to confirm and identify the origin and to delineate the extent of this anomaly.

Insufficient data were collected at Lampton Dome to define the local hydrogeology. Data collection efforts were curtailed by direction from ONWI (Law Engineering Testing Company, 1979) before adequate data could be gathered.

Analyses were conducted at all three candidate domes to determine average ground-water flow times and flow paths from various depths below the fresh-water base to the base of fresh water. Vertical flow times to the base of fresh water from depths of 300 and 457 meters (1,000 and 1,500 ft) below exceeded 100,000 and 225,000 years, respectively, at Richton and Cypress Creek Domes. The estimated horizontal flow time from Site MRIH-11 near Richton Dome to Site MCCH-3 near Cypress Creek Dome at -914 meters (-3,000 ft) MSL was about 25,000 years. The quantity of water flowing south at Richton Dome greatly exceeds that flowing south at Cypress Creek Dome at elevations of -701 and -914 meters (-2,300 and -3,000 ft) MSL. Most of the water that flows south from Richton Dome at these elevations either discharges vertically to overlying formations between Richton Dome and Cypress Creek Domes, diverges to the east and west around the Perry Basin, or flows downward into underlying formations. Further investigation is needed to better define flow paths in the vicinity of Richton and Cypress Creek Domes. Estimated vertical flow times to the base of fresh water from various depths below this base at Lampton Dome under natural conditions are similar to those computed for the other two domes. Insufficient data were collected at Lampton Dome to estimate horizontal flow conditions under natural conditions. The results of these analyses indicate that the estimated average vertical groundwater flow times are long and that significant differences in these flow times among the candidate domes cannot be substantiated with the existing data.

Areas overlying the three candidate domes that would be inundated by flooding of streams were delineated. Data needed for these studies were taken from U.S. Geological Survey 1:24000 scale quadrangle maps. No field data were obtained. A surface facility of about 162 hectares (400 acres) could be placed over the Richton or Lampton Domes without major drainage relocation problems. Surface drainage could be an important design consideration for a surface facility at the Cypress Creek Dome.

14.5 LIST OF REFERENCES CITED

Back, W., 1966, Hydrochemical facies and ground-water flow patterns in northern part of Atlantic Coastal Plain: U.S. Geological Survey Professional Paper, 498-A, 42p.

Back, W.; and Hanshaw, B. B., 1965, Chemical geohydrology: Advances in Hydroscience, V. 2, p. 49-109.

Bicker, Alvin R. Jr., 1970, Economic minerals of Mississippi: Mississippi Geological, Economic and Topographical Survey, Bulletin 112, 80 p.

Bicker, Alvin R., Jr., 1972, Salt water disposal wells in Mississippi: Mississippi Geological, Economic, and Topographical Survey Information Series MGS-72-4, 92 p.

Boswell, E. H.; Thompson, F. H.; and Shattles, D. E., 1970, Water for industrial development in Clarke, Jasper, Lauderdale, Newton, Scott, and Smith Counties, Mississippi: Mississippi Research and Development Center, 62 p.

Callahan, J. A., 1975, Water use in Mississippi, 1975: U.S. Geological Survey Water Resources Investigations 76-125 .

Ellison, B. E.; and Boswell, E. H., 1963, Water levels and artesian pressures in observation wells in Mississippi: Mississippi Board Water Comm.

Fair, G.M., and Geyer, J.C., 1956, Water supply and waste disposal: John Wiley & Sons, Inc.

Freeze, R. A.; and Cherry, J. A.; 1979, Ground water: New Jersey, Prentice-Hall Inc. 604 p.

Gandl, L. A.; and Spiers, C. A., 1980, Results of water quality sampling near Richton, Cypress Creek and Lampton Salt Domes, Mississippi: U.S. Geological Survey Open File Report 80-443.

Geological Survey of Alabama, 1969, Generalized geologic map of Alabama: Modified From U.S. Geol. Survey, 1932, Geologic map of the United States.

Harvey, E. J., 1963, Compilation of aquifer test data for Mississippi: Mississippi Board Water Comm., 10p.

Keady, D. M., 1970, A study of the hydrochemical facies of the Wilcox aquifers in Mississippi: Water Resources Research Institute, 40p.

Law Engineering Testing Company, Inc., 1979, Geologic evaluation of Gulf Coast salt domes, Technical Work Plan, October 24, 1979: Marietta, Georgia.

______________________________, 1980, Gulf Coast Salt Dome Geothermal Study, 51 p.

Lusczynski, N. J., 1961, Head and flow of ground water of variable density: Journal of Geophysical Research, V. 66, No. 12, p. 4247-4256.

Lusk, T.W., 1953, Water levels and artesian pressures in observation wells in Mississippi: Mississippi State Geol. Survey, 65p.

Mississippi Geological Survey, 1976: Geologic map of Mississippi.

Newcome, Roy, Jr., 1975, The Miocene aquifer system in Mississippi: U.S. Geol. Survey Water Resources Investigation, 76-17.

Pacific Northwest Laboratories, August 1979, Reference site initial assessment for a salt dome repository, PNL 2955, Vol. 1, for Office of Nuclear Waste Isolation: Battelle Memorial Institute.

Parker, J.W., 1967, Ion ratios, water analyses, and subsurface fluid relationships, East Texas Basin: Unpub. Dissertation, Univ. of Texas, Austin, Texas, 209p.

Parker, J.W., 1969, Water history of Cretaceous aquifers, East Texas Basin: Chem. Geol. V. 4, p. 111-133.

Pearl River Valley Water Supply District, 1959, Project planning report-Pearl River valley reservoir (Ross Barnett reservoir): Lester Engineering Company and Harza Engineering Company, 76p.

Shows, T. N.; and others, 1966, Water for industrial development in Forrest, Greene, Jones, Perry, and Wayne Counties, Mississippi: Mississippi Research and Development Center Bull., 72p.

Soil Conservation Service, 1968, Water and related land resource development plan for the Pascagoula River basin: U.S. Department of Agriculture, Economic Research Service, Forest Service, 187p.

Slaughter, George M., 1981, An analysis of ground-water flowtimes near seven Interior salt domes: Law Engineering Testing Company, Final Report, 88 p.

[redacted]

Spiers, C. A., 1977, The Cockfield aquifer in Mississippi: U.S. Geological Survey Water Resources Investigation, 77-17.

Taylor, R. E., and others, 1968, Water for industrial development in Covington, Jefferson Davis, Lamar, Lawrence, Marion, and Walthall Counties, Mississippi: Mississippi Research and Devel. Center Bull., 114p.

U.S. Army Corps of Engineers, 1970, Pearl River comprehensive basin study: Mobile District, Corps of Engineers, Department of the Army, 90p.

U.S. Geological Survey, 1978, Water resources for Mississippi, 1977: U.S. Geological Survey Water-Data Report MI-77-1.

Watt, H. B., 1975, Epilogs, A complete analysis of complex and sandstone reservoirs: Dresser Industries Technical Memorandum, V. 6, No. 1, 8 p.

REVIEW COMMENTS TO DRAFT REPORT WITH REPLIES

379

Comments on the Final Draft, Mississippi Area Characterization Report, by Dr. Velon Minshew of the Mississippi Mineral Resources Institute

1. Page 12-B, Paragraph 2. "Topographic relief of approximately 300 feet is typically developed by strained section (sic). Three hundred feet is not gentle.

The referenced Area Characterization Report paragraph states that surface elevations range from 100 feet MSL in the stream valleys to approximately 400 feet on the hills in the interstream areas. The difference between the extremes in elevation is the source for the 300 feet of relief. The relief is not abrupt (Figure 12-2) but is indeed a gently rolling transition between the hills and valleys.

2. Page 12-11, Paragraph 3. "Known faults are not obviously reflected in the surface, nor do they generally coincide with lineaments in the study area." This is not true. There is not enough evidence to make this statement. Where these have been studied in detail, they do coincide.

All of the faults shown on Figure 12-12 were projected to the surface at a range of angles typical of faulting in the Gulf Coast. No definite correlation was found between the fault projections and lineaments in the study area.

3. Page 12-12, Paragraph 2. "Topographic elements in the study area have little preferred surface orientation ...". This is not true.

This ACR statement refers to lack of structural control of topographic expression. Topographic expression controlled by drainage and the attitude of strata is acknowledged in Section 12.2.

4. Page 12-12, Paragraph 2. "Erosional processes are controlled by three factors -- regional structure, lithology of the outcropping strata, and base level change." How about local structure? In my opinion, local structure would be far more dominant control than regional structure.

The text has been changed to read: Three factors ... regional and local structure ...

BEST DOCUMENT AVAILABLE

5. Page 12-12, Paragraph 3. "Longer streams and gently rolling topography are characteristic of the gentler slope, which generally dips to the southwest." A slope is inclined and does not dip.

The word "dips" has been changed to "slopes".

6. Page 12-13, Paragraph 1. These lithologic descriptions are so general and so vague to be useless (sic). They will fit at least 60% of all the geologic units which are present in the Mississippi salt embayment.

The descriptions on this page are a summary of descriptions in Sections 12.2.2.3.4 and 12.2.2.4. The intent of this section was to furnish generalized lithologic descriptions to characterize the strata which crop out in the study area. A more detailed treatment can be found in Section 12.2.2, Stratigraphy, Table 12-2, and in Chapter 13.

7. Page 12-13, Paragraph 2. It is inferred that the Citronelle formation is a widespread unit formed at the same time. These (sic) is little evidence to suggest a single age for the Citronelle, and to imply this is taking tremendous liberties.

Simultaneous deposition of the Citronelle is not inferred by this paragraph.

8. Page 12-13, Paragraph 2 - last sentence. "Thus, the Citronelle is the oldest and topographically the highest coast wise terrace (May, 1974), and where terraced, recent alluvium compose the lowest, youngest terrace." Do you mean to say here that the Citronelle is terraced?

The Citronelle is the highest and oldest terrace. Dissection of the Citronelle terrace resulted in the formation of lower, younger terraces. Where recent alluvium is dissected and a terrace formed, it is the lowest, youngest terrace.

9. Page 12-15, Paragraph 1 states: "Visual assessment of the study area drainage reveals no local anomalies." Paragraph 3 states: "Most long (greater than 25 miles) lineaments in the study area correspond to major trunk channels in the drainage system ..." There seems to be a definite contradiction between the two paragraphs. Minshew and others established excellent correlation between structures and stream patterns.

There is no contradiction in these two statements. Most long lineaments do correspond to major trunk channels in the drainage system. A 25-mile lineament is not a local anomaly.

10. Page 12-15, Paragraph 3. "Lineaments identified from color infrared ariel (sic) photographs show a strong bi-modal orientation, ..." (End paragraph). This is exactly the orientation that should be expected in a techtronic (sic) terrain formed by an expanding flunk (sic).

This comment apparently contains typographical errors which render it unintelligible. Thus, a response cannot be given.

11. Page 12-16, Paragraph 2. "Long (40 mile) linear belts of low lineament density occur at several places in the study area. These belts correspond to the major drainage courses and are due to masking of structural features by thick alluvial deposits." This is a contradiction of only a page or two back. I think someone should make up his mind as to whether they are structural or not.

The belts of low lineament density are due to the masking of lineaments by thick alluvial deposits. This sentence has been changed to read: "... masking of lineaments by thick alluvial deposits."

12. This table is so small that it is absolutely useless.

We feel that Table 12-1 is quite legible.

13. Page 12-27, Paragraph 3. The Louann Salt is discussed almost entirely from the basis of its' (sic) age. It is the nature and composition of the salt which is important, not its' (sic) age.

The composition of the "mother" salt is addressed in this paragraph. No wells drilled in the study area have penetrated the mother salt. The closest well which did is in extreme southern Perry County and did not recover any salt. The composition of the salt in domes cannot be inferred directly from the composition of the "mother" salt. Salt from two of the candidate domes was cored during Area Characterization and is described in sections 13.1.1 and 13.3.1. Detailed study of the dome salt composition is planned for Location and Site Characterization.

14. Page 12-27, Paragraph 5. Luark (sic) Group. I rarely hear this term used in Mississippi. Also, formations are not depositional environments as your first sentence would seem to indicate.

For greater clarity we have changed the first sentence to read: "Haynesville - Buckner Formations which were deposited in near shore to open marine environments ...". The name Louark Group is contained in Bulletin 118, "Mississippi Geologic Names" published by the Mississippi Geological, Economic and Topographical Survey in 1973.

15. Page 12-28, Paragraph 1. "The Norphlet Formation, consisting of poorly sorted, shaley sandstones and sandy shales, unconformably overlies the Louann Group ...". This is freshman-level geology and should not be included in a report of this nature. Also in that paragraph, I might mention in many areas that Buckner is almost entirely an anhydrite.

Section 12.2.2 was not intended to furnish a detailed discussion of stratigraphy, but rather, it presents an overview as a basis for characterizing the study area stratigraphy.

16. Page 12-28, Paragraph 2. "The Cotton Valley Group undifferentiated, is a sequence of fine- to medium-grained sandstones alternating with mudstones and shales (Dinkins, 1968)." This description would fit 99% of the units in the area.

This description of the Cotton Valley Group is referenced to Dinkins (1968) where a more detailed description can be found. As stated in the previous response, a detailed stratigraphic treatment was not intended for this section.

17. Page 12-29, The Nuevo-Leon Group. Paragraph 2. This is a term that is very very rarely ever used in Mississippi. In the same paragraph you mention that the Hosston Formation contains hydrocarbon producing zones. The Hosston Formation is probably the most significant gas producing zone in Mississippi. Any knowledge of the recent activity within the past two years in Mississippi would have proven this out.

By use of the term hydrocarbon, any organic compound, gaseous, liquid or solid, consisting solely of carbon and hydrogen is included. Thus, the Hosston Formation is not excluded as a gas-producing zone.

Paragraph 4. The Trinity Group. This is not a Mississippi term and you mention that the unit is up to 3,800 feet thick. What is the lower range of thickness?

The Trinity Group is a recognized Mississippi name and is listed as being up to 3,800 feet thick by Childress (1973) in "Mississippi Geologic Names", Bulletin 118, published by the Mississippi Geological, Economic and Topographical Survey. The lower range of thickness was not reported.

18. Page 12-30, Paragraph 1. The first paragraph is jumbled and not of value.

This paragraph as been revised for greater clarity.

19. Page 12-31, Paragraph 1. Does this paragraph indicate that everything is conformable and identifiable? Are there no facies changes? Are there no unconformities within the entire sequence?

The stratigraphy of the study area, Section 12.2.2 was not intended to be an exhaustive treatise on stratigraphic details. Rather, it presents an overview of the stratigraphic setting in Southern Mississippi as presented in a consensus of literature sources. It is well referenced for those interested in additional information.

20. Page 12-31, Paragraph 3. "The interpreted structure on top of the Lower Tuscaloosa Formation is shown in Figure 12-13 and is discussed in Section 12.2.3." This is totally out of place and should not even be mentioned here.

An editorial decision was made to assist the reader in this section by making reference to those formations which underwent detailed structural analysis.

21. Page 12-32, Paragraph 1. The first paragraph is written in such a fashion that evidently the writer has never heard of facies patterns and variations. I cannot believe that the units are as simple as described herein.

The stratigraphy of the study area, Section 12.2.2 was not intended to be an exhaustive treatise on stratigraphic details. Rather, it presents an overview of the stratigraphic setting in Southern Mississippi as presented in a consensus of literature sources. It is well referenced for those interested in additional information.

22. Page 12-33, Last Paragraph. This entire paragraph is sophomoric level text. This type of information is of no value in evaluating a regional picture.

As discussed in the response to Item 19, this section was not intended to be an exhaustive treatise on the stratigraphy of Southern Mississippi. Rather, it presents an overview of the general stratigraphic setting of the region based on the geologic literature, and is well referenced for those interested in additional information.

23. Page 12-34, Paragraph 1. States that the Wilcox Group conformably overlies the Midway Group. This is open to question and certainly will vary from area to area.

Bulletin No. 108 of the Mississippi Geological, Economic and Topographical Survey (Dinkins, 1967) describes the Wilcox-Midway contact as transitional. While this may vary from area to area, the above reference refers to George County, Mississippi which is adjacent to the Mississippi study area boundary.

24. Page 12-35, Paragraph 1. How is it possible to determine in the subsurface that an unconformity does or does not exist? Paragraph 2 states: "The Kosciusko (Sparta) Formation, which is locally sandy, consists of chalky or calcarenitic limestones, and clay shales ..." Where does it consist of this? Throughout much of the state it definitely consists of sand.

As discussed in the responses to Items 19 and 22, this section merely presents an overview of the general stratigraphic setting of the region. It is well referenced for those interested in additional information.

25. Page 12-35, Paragraph 2. It is intriguing that all of the units are conformable.

The nature of the contacts between the various units was taken directly from various literature sources which are well referenced in the text.

26. Page 12-37, Paragraphs 1 and 2. The accuracy of the thickness of these units is absolutely precise, for instance, "11 to 91 feet" or "46 to 215 feet". Such accuracy impresses me.

The thickness of the various units of the study area described in this section were derived from a review of electric-log picks from wells in the study area. It is possible in most cases to determine the thickness of a unit to the nearest foot from an electric log. Thicknesses obtained from literature sources are commonly less precise.

27. Page 12-38, Paragraph 1. "The Catahoula Formation and the Pascagoula-Hattiesburg unit are the only Miocene and Plio-Miocene sequences containing potentially significant mineral resources." What other geologic units do you have in this area? The next sentence states: "The Catahoula Formation contains minor lignite interbeds, whereas the Pascagoula-Hattiesburg unit contains sands and gravels used in construction, clays used in brickmaking, and minor interbedded lignites (Logan, 1908; Mississippi State Oil and Gas Board, 1977)." Is a 45 foot bed of lignite minor?

The first quoted sentence has been deleted. The word minor has been deleted from the other quoted sentence.

28. Page 12-39, Paragraph 2. "These flood plains were subsequently incised to form terraces and the products there from moved farther downstream." The meaning of this sentence is totally lost.

This sentence has been changed to read: "These floodplains were subsequently incised forming terraces and the eroded floodplain material was deposited downstream."

29. Page 12-40, Paragraph 2 states that: "... the (Mississippi salt) basin lies within ... the Mississippi Embayment ...". To the best of my knowledge, this is not true.

Paragraph 2. To the best of my knowledge, the Mississippi Embayment does not extend into east Texas and western Alabama. Paragraph 3 has stated that : "... the basin is bounded on the north by the Pickens-Gilbertown

Fault Zone and on the south by the Hancock County High, ...". It is bounded by the Williams (sic) uplift but certainly not the Hancock County High.

The following quotes are from Geology of the Atlantic and Gulf Coastal Provinces of North America, by G. E. Murray, 1961: (1) "Salt Domes, ... occupy a large area in the southern portion of the embayment ... (page 109). (2) "The Mississippi embayment ... is situated in parts of Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, Alabama, East Texas, and Louisiana. When viewed in overall perspective, effects of this great downwarp are reflected eastward as far as Alabama, and westward about 400 miles into east Texas." (page 107.)

The description of the Hancock county high as the southern boundary of the Mississippi salt basin is based on the second interpretation for the origin of the Wiggins anticline cited in Section 12.2.3.3. The Phillips Josephine well encountered salt on the northern flank of the Wiggins anticline which suggests that it is not the boundary of the salt basin.

30. Page 12-41, Paragraph 1 mentions that: the Perry Basin involves basement structure. Paragraph 2 states that: "The Perry Basin is apparently a large salt withdrawal basin." There seems to be a contradiction between the two paragraphs. The first sentence of Paragraph 2 states that the Wiggins Anticline is located within the Mississippi Basin. I have never heard this included in the Mississippi Basin before. Paragraph 2, next to the last sentence states that: "... the Wiggins Anticline may be the result of crustal subsidence and flexure due to sediment loading." A far better explanation involves flake (sic) movements.

Paragraph 1 does not refer to the Perry Basin but to the Mississippi interior salt basin. As stated in the response to Item 29, the presence of salt on the northern flank of the Wiggins anticline indicates it is located within the Mississippi interior salt basin.

31. 12-42, Paragraph 1. "Each dome is typically associated with local normal faults, anticlines, and synclines formed by the movement of diapiric salt structures or non-piercement salt swells." This sentence should be remembered and should be noted as we continue because faults evidently, according to the text later on, are exceedingly rare around both Cypress Creek and Richton. Paragraph 2 indicates uplift of 2 to 4 mm/year along a part of the area under study. It should be emphasized that 4 millimeters per year of uplift is not stable.

Identification of faults associated with salt domes is a function of the amount of data available. More detailed studies of near-dome structure are planned for Location and Site Characterization. The tectonic instability indicated by Holdahl and Morrison (1974) is undergoing validation by Cornell University. Further comment is best delayed until Cornell's study is complete.

32. Page 12-43, Paragraph 2. "The number of faults recognized (sic) also decreased up through the stratigraphic section." I suspect that this is more apparent than real because obviously the amount of throw would decrease upward throughout the stratigraphic section and few seismic profiles or structure contour maps are of such accuracy to be able to recognize small scale displacement. Paragraph 3 states: "The general strike of the units mapped shifts progressively westward from a northerly trend on the older horizons to westerly on the younger horizons...." Where does this take place? The text does not say.

It is possible that in some parts of the study area faulting has not been recognized in the shallow subsurface due to small fault throws and the inability of conventional exploration methods to detect small magnitude faulting. The text refers to Figures 12-13 through 12-20 in its discussion on the shift in strike through time. This shift is a gradual one and is readily apparent when comparing the strike on top of the Lower Tuscaloosa Formation (Figure 12-13) to that on the top of the Vicksburg Limestones (Figure 12-20).

33. Page 12-45, Paragraph 1. "... reflectors below the Hosston are inferred and the interpretation does not seem to reflect known structural trends." Then why do it?

The precise elevation and stratigraphic position of reflectors below the Hosston is inferred due to the fact that inadequate velocity data exist because very few wells were drilled below the Hosston. However, these reflectors were interpreted in order to better understand the growth history of the domes, to demonstrate that reflectors below the Hoston are traceable, and to gain insight into the regional structure.

34. Page 12-52, Paragraph 1. Paragraph seems to contradict earlier statements completely.

No specific contradictions are cited, therefore no response is required.

35. Page 12-54, Paragraph 2. "The proximity of Cypress Creek Dome to the Perry Basin suggests the possibility that the basin is a salt withdrawal feature." This is ridiculous.

Since no facts are offered to support the reviewer's position, it is difficult to comment on this position. The Mineola Basin in Texas and the Minden Basin in Louisiana are both postulated to be salt withdrawal basins related to the growth of the Haynesville and Minden domes, respectively. The Perry Basin, which encloses Cypress Creek Dome exhibits many similarities to these other basins.

36. Page 12-56, Paragraph 2. "The dominant trend of the strike of the fault planes in the area is to the southeast-northwest ..." There is also a very very strong northerly fault component throughout this area.

Deviations of fault trends from the dominant southeast-northwest trends are discussed in the referenced paragraph.

37. Page 12-57, Paragraph 2. It is stated that the fault under discussion is not recognized in the younger sediments and this is simply because of decreased throw on the fault upward.

Another possibility is that the Pistol Ridge - Maxie Fault is not recognized in the younger sediments because it died out prior to deposition of these sediments.

38. Page 12-58, Paragraph 1. It should be noted that the Phillips Fault Zone occurs within 5 miles of the Richton Salt Dome according to this report. It should also be noted that Oscar Paulson of the University of Southern Mississippi has recently (sic) documented that large scale (sic) strike-slip movement has occurred along the Phillips Fault Zone. It should also be remembered that the Phillips Fault Zone is one of the largest, if not the largest, fault zones in Mississippi.

The Phillips fault as postulated by Oxley et al (1968) was taken into consideration during this report. However, it should be noted that other investigators, notably Morgan 1970, have found no evidence of major faulting.

A detailed investigation of this postulated fault system is planned for the next phase of investigation.

39. Page 12-58. In quoting Oxley and others, it is said that, "A maximum amount of fault throw as evidenced by missing section in several weeks (sic) would include a fraction of ..." I fail to understand this statement.

This statement contains a typographical error. The word "weeks" has been changed to read "wells".

40. Page 12-61, Paragraph 1. "The closest proximity of faults in the Baxterville structure to Lampton, Richton, and Cypress Creek Domes is approximately 9, 41, and 34 miles, respectively." This is a meaningless statement and serves no purpose whatever.

This report may form the basis of a licensing document to be reviewed by the Nuclear Regulatory Commission. Because the NRC Regulatory Guidelines require determination of the distance between a site and all faults within a given radius, the information was presented.

41. Page 12-62, Last paragraph. "Of greater importance are regional faults that may extend from one structure to another and are therefore independent of local salt movements. No regional faults were identified from the interpretation of seismic and well data." An earlier statement said that nothing could be recognized below the salt. Therefore, how are we going to recognize major regional features as almost assuredly these features would involve basement movement. Also, it is not possible for the State of Mississippi to verify a statement of this type since we do not have the data such as seismic profiles to double check it.

It is true that faulting which exists only below the salt cannot be recognized with conventional seismic data. However, such faults, if present, would not be considered capable by NRC criteria and therefore are not a cause of concern for the integrity of a potential repository site. Proprietary seismic data are available from brokers and may be obtained by the state. All nonproprietary data have been transmitted to the state under their FOIA request.

42. Page 12-66, Paragraph 3. "The proximity of this fault system to Sunrise Dome suggests that faulting is the result of tensional stresses created by salt movement." Does it parallel a salt ridge system?

Sunrise and Petal Domes are two of the smallest domes in the study area and their proximity to one another may indicate that they are underlain by a salt anticline. There is, however, no direct evidence for the existence of a salt ridge in this area.

43. Page 12-69, Paragraph 1. "Strata across the fault are downthrown to the north approximately 900 feet." On the basis of the discussions of the faulting associated with Cypress Creek and Richton Dome, in my opinion, both domes must be eliminated at this time.

The existence of faulting in Gulf Coast sediments is not an a priori reason for elimination of any candidate dome. The age of last movement along any fault is the critical factor.

44. Page 12-71, Paragraph 3. "The proximity of this fault zone to the Phillips Fault System suggests that the two may be related. However, a previous discussion, referencing Morgan (1970), questions whether the Phillips Fault System does, in fact, involve faulting." This, in my opinion, is invalid. Almost all work that has been done with the Phillips Fault System suggests that it is a very large-scale fault of regional magnitude with displacement both horizontally and vertically.

This comment is directed at Morgan's conclusions and therefore cannot be answered by us. However, the importance of gaining a better understanding of the Phillips Fault System is recognized, and it has been designated as a key issue for further study during Location and Site Characterization.

45. Page 12-72, Paragraph 2. "The proximity and radial orientation of these faults with respect to Glazier Dome suggest that they are related to domal growth." If there are faults of this type around Baxterville, Hub, Glazier, Sandhill and others, why is it that Richton Dome and Cypress Creek are unique in not having extensive fault systems?

As discussed in the response to Item 31, identification of faults near salt domes is a function of the amount of available data. Cypress Creek and Richton Domes will be studied in more detail during Location and Site Characterization.

46. Page 12-73, Last paragraph. It is important to note the following sentence: "The sediments surrounding the dome dip steeply and are faulted." This refers to Lampton Dome.

We agree, this statement is important.

46. (sic) Page 12-74, Paragraph 3. "Pre-Miocene beds surrounding the dome are tilted and faulted, but no known faults affect beds on top of the dome." I can not imagine the faults surrounding the edge of the dome to be tilted and faulted and not above the dome, where the greatest amount of displacement would have occurred.

This discussion presents conclusions made by Eargle (1968) and Anderson and others (1973). We are not in a position to defend all literature referenced in the Area Characterization Report.

47. Page 12-81, Last paragraph. It states that: "Oil and gas production began in the Mississippi Salt Basin about 1930". Tinsley Field, the first field in Mississippi, was not brought in until 1939.

The text has been modified to read: ...began in the Mississippi Salt Basin about 1939.

48. Page 12-82, Last paragraph, last sentence ... "The Melvin earthquake may have been induced by operations in any of these oil and gas fields." This would have to be proven and I seriously doubt it.

Minor earthquake activity along the Pickens-Quitman-Gilbertown-Pollard Fault Zone seems to be confined to areas which were producing hydrocarbons at the time of the earthquakes. The only way to prove relationships such as those conjectured in the text is to establish a micro-seismic array along the Pickens-Quitman-Gilbertown-Pollard Fault Zone to monitor hydrocarbon producing and nonproducing zones for some period of time. One can seldom prove the cause of a random, poorly instrumented transient event, such as an earthquake, after the fact.

49. Page 12-84, Top of page; first sentence. "No tectonic features capable of generating earthquakes were identified within the study area." The Phillips Fault Zone and the thousands of other faults throughout the area, some with displacement of 3000 feet or so, certainly are capable of generating earthquakes within this region.

The phrase "tectonic features capable of generating earthquakes" is a phrase used by the NRC to characterize tectonic structures which have generated earthquakes and/or surface displacements during the last 35,000 years. Tectonic structures include basement faults, flexures, and igneous intrusions. The number of faults or total displacements along a fault are not the critical parameters for siting an NRC-licensed facility. The type of fault, ground-motion, and last known activity are the critical factors. The conjectural "Phillips Fault Zone" and "the thousands of other faults" have not yet qualified as tectonic features capable of generating earthquakes, according to the NRC criteria being used to evaluate and license a site.

50. Page 12-86, Paragraph 2, last sentence. "... it seems unlikely that the domes within the study area will yield any significant amounts of hydrocarbons." This is a presumptious (sic) statement and can not be verified.

The following is paraphrased from a topical report entitled: "An Evaluation of Potential Mineral Resources in the Vicinity of Seven Interior Salt Domes" by G. H. Fogle and G. E. Murray, Prepared for BMI/ONWI, June 1981:

In the 100 years that salt domes have been known in the Gulf Coastal Province of the United States, approximately 100 domes have been identified as shallower than 5000 feet MSL. These interior shallow piercement structures have been the objects of substantial exploration. As of January 1, 1979, some oil and gas had been found in association with 14 or 15 of those 100 domes. The sediments around only 5 of the interior domes have yielded 1,000,000 or more barrels of oil or the gas equivalent. No dome in Mississippi or Alabama has produced as much as 250,000 barrels of oil or gas equivalent. None of the domes have yielded deep flank production to date.

51. Page 13-8, Paragraph 1. The study area around Cypress Creek Dome, 7 by 9 miles, is totally inadequate to do an evaluation.

The 7 mile by 9 mile area did not limit the geologic evaluation. The area selected received more detailed study than the outlying areas, but the defined area did not impose any arbitrary restraints on the evaluation.

52. Page 13-9, Paragraph 1. Cypress Creek Dome has been modeled as to its' (sic) size. However, a model must be remembered to be nothing but a model. Where is the proof of the size?

The model of Cypress Creek Dome is a state-of-the-art model utilizing well data, high-resolution seismic data and gravity data. Further refinements to the model will be made when additional data are gathered during Location and Site Characterization.

53. Page 13-9, Paragraph 3. The caprock in some places is as thin as ten feet.

Well data indicate that the caprock is a minimum of 36 feet thick whereas the dome model indicates the caprock thins to a feather edge (Figure 13-6) on the flanks of the dome.

54. Page 13-10, Paragraph 2. It is very important to note that the salt in Cypress Creek is very very immature and some places, according to this report, contain as much as 25% anhydrite.

A vertical corehole was drilled into essentially vertically bedded salt in the dome. As such, it is inadvisable to make sweeping generalizations about the composition and maturity of the domal salt from one corehole. Further investigations to characterize the salt are planned during Location and Site Characterization.

55. Page 13-11, Paragraph 3. The Cypress Creek is overlain by a swamp which, undoubtedly, is the surface expression of salt dissolution at depth.

The possibility that the swamp is a surface expression of salt dissolution is discussed in Section 13.1 along with alternate theories for the existence of the swamp.

56. Page 13-12, Paragraph 3. "The absence of positive relief concentric to the supradomal area suggests that there has been no post-depositional upward domal movement to deform the outcropping beds." If substance (sic) associated with dissolution were present, we would not expect to find such features.

Subsidence related to salt dissolution would be confined to the area overlying the salt stock whereas uplift of the overlying beds would produce positive relief over a much larger area. Also, the magnitude of the subsidence is unlikely to correspond exactly to the magnitude of the uplift.

57. Page 13-13, Paragraph 1. "This surficial morphology suggests subsidence in the supradomal area. The course of Cypress Creek changes rather abruptly across the dome from southeasterly to southwesterly (Figure 13-14), and this is anomolous (sic) relative to nearby channels of equivalent order." This certainly should be investigated as it is most probably fault controlled.

Further investigation of Cypress Creek Dome is planned during Location and Site Characterization.

58. Page 13-14, Paragraph 1. "The contours of drainage ratio show a decrease in fluvial activity over the dome, which is apparently related to lower relief there, as well as to localized aggradation by Cypress Creek." Again, this seems to be a substance-related (sic) phenomenon. Paragraph 2 states that shallow borings indicate that the Hattiesburg and Citronelle are present at the surface near the dome. How many borings were made to determine this?

As discussed in the response to Item 55, the possibility that the swamp over Cypress Creek Dome is related to subsidence is discussed in Section 13.1. The outcrop pattern was determined by analysis of geologic mapping data and data from 50 shallow borings. The locations of the shallow borings are shown on Figure 13-18.

59. Page 13-16. In Texas, where the lineaments coincide with drainage features, they are almost always structurally controlled as evidenced by the Texas report. I find it ironic that this is not the case in Mississippi. Also, in Paragraph 2, you mention channel sands in Hattiesburg Formation. Earlier, your report referred only to a sand in the Hattiesburg Formation. Which is it?

Section 13.1.2 discusses the erosion of a large sand body composed of channel sands within the Hattiesburg Formation to account for the presence of a long lineament. There is no contradiction between the discussions presented in that section.

60. Page 13-19, Paragraph 1. "The Winona, Cockfield, Yazoo and Chichasawhey (sic) contain more sand in the Cypress Creek Dome area than is indicated in the regional descriptions." The regional descriptions are so generalized that this statement is totally meaningless.

The regional descriptions, meant as summary statements, are taken from the literature and are well referenced in the text.

61. Page 13-20, Paragraph 1. "Variations in the domal growth, coincident with subsidence of the Perry Basin, are apparently responsible for the corresponding variations in formation thicknesses in the near-dome area." I have found nothing in the text to indicate that a statement such as this can be made.

The Area Characterization Report presents data in the form of structural contour and isopachous maps (Figures 12-13 through 12-22) and interpreted conventional and high resolution seismic sections (Figures 12-26, 12-27, and 13-10), upon which the hypothesis for the development of the Perry Basin and its relationship to Cypress Creek Dome is based.

62. Page 13-21, Last paragraph. "The Citronelle, which is a nearly flat-lying unit, was deposited on an erosional surface which has a typical relief of about 200 feet across the near-dome area." Nowhere else that I am familiar with the Citronelle is such relief present. Therefore, I suggest that the apparent amount of relief may be due to faulting.

The 200 feet of relief is the total change in elevation across the near-dome area. Figure 13-22 is a contour map of the top of the Hattiesburg Formation at a 20-foot contour interval and exhibits no evidence of faulting.

63. Page 13-22, First sentence. "... contact varies from about 60 feet MSL in the southeastern portion of the dome area to 257 feet MSL in the northern portion ...". What is the configuration of this erosional surface? A map drawn on the erosional surface, if sufficient data are present, could be very revealing as to the nature of the surface. Is it erosional or is it faulting?

As discussed in the response to Item 62, Figure 13-22 is a contour map on the erosional Hattiesburg surface and shows no evidence of faulting.

64. Page 13-22, Paragraph 3. It is stated that the salt penetrated Miocene beds. Therefore, a post-Miocene age is established for salt movement in this area. In the same paragraph, it is stated that the maps do not indicate that the salt stock has a pronounced influence on the near-dome geologic structure. I agree with their statement as the fact that this is almost certainly due to positive well data.

No response is required.

65. Page 13-23, Paragraph 1. Concerning the Miocene beds, the report states: "These beds are upturned approximately 200 to 500 feet within 2,000 feet of the dome flank." Your illustrations in the other volume do not agree with this and show no apparent uplift of the beds. I would suggest that 500 feet of displacement is strongly affected.

The sentence referred to in Item 65 makes reference to two high-resolution seismic sections (Figures 13-9 and 13-11). These two figures do, in fact, show uplift of Miocene strata from 200 to 500 feet within 2,000 feet of the dome flank. Five hundred feet of vertical uplift over a horizontal distance of 2,000 feet is equivalent to approximately 14° of dip and is not unusual for sediments surrounding a salt stock.

66. Page 13-23, Paragraph 2. The statement is made that: "... the Perry Basin is thought to be a salt withdrawal feature related to Cypress Creek Dome ... and may be the largest rim syncline identified in the study area." This is the most ludicrous statement I have ever heard or read in any publication!

The response to Item 61 outlines the data presented in the Area Characterization Report to support this hypothesis. Since almost all of the structure in the Mississippi study area is controlled by salt movement, it is certainly a valid hypothesis that subsidence of the Perry Basin is related to salt withdrawal into Cypress Creek Dome in the same manner that the Minden Basin in Louisiana is related to salt withdrawal into Minden Dome, and the Mineola Basin in Texas is related to salt withdrawal into Haynesville Dome.

Section 12.2.3.2 discusses the time of inception of the Perry Basin subsidence as Paleocene/Eocene indicating that the basin is a salt-controlled structure. Thus, it is a valid assumption that some of the salt evacuated from beneath the basin flowed into the Cypress Creek salt stock.

67. Page 13-24, Paragraph 3. States that there is no correlation between known faults and lineaments at the surface. In both the Louisiana study and the Texas study and in studies conducted by the University of Mississippi in this area, a strong correlation has been found between surface lineaments and known faults.

The paragraph in question merely discusses the lack of correlation between the surface projection of subsurface faults and lineaments detected during the study.

68. Page 13-24, Paragraph 4. "Analyses of the structure of the surficial units ... indicate that subsidence of supradomal beds has taken place in Quaternary. This is evidenced by the presence of a closed depression on the Hattiesburg-Citronelle contact over the dome crest ...". Therefore, the presence of a salt solution feature above Cypress Creek Dome, in my opinion, is well established.

The presence of solution-related subsidence is discussed in Section 13.1.2.

69. Page 13-25, Paragraph 1. "In addition, a reduction-oxidation sequence in the Quaternary alluvium also indicates substance (sic) over the dome." The reasons for this statement are very very unclear.

The significance of the reduction-oxidation sequence in the Quaternary alluvium is explained in Section 13.1.2.

70. Page 13-25, Paragraph 2. The entire second paragraph tried to explain the depression above Cypress Creek Dome as anything other than direct evidence of Pleistocene to Quaternary substance (sic) is not valid.

The direct evidence for Pleistocene (Quaternary) subsidence is discussed in Section 13.1.2. This paragraph refers to the anomalously thick section of Quaternary alluvium in the supradomal area.

71. Page 13-25, Last paragraph. It is stated, "Approximately 50 feet of alluvium was encountered over the sag in the Hattiesburg-Citronelle contact beneath the swamp." The dating of this material, alluvium, above the depression is of crucial importance.

We agree that the dating of the alluvium is important to determine the timing of subsidence over Cypress Creek Dome. Further studies will be accomplished during Location and Site Characterization.

72. Page 13-26, Paragraph 1, last sentence. "This shallow, subsurface evidence for domal subsidence is supported to some extent by evidence of possible dissolution of the salt ...".

Since this is merely a quote without a comment, a response cannot be made.

73. Page 13-27, Paragraph 3. States: "Although Cypress Creek Dome is situated along the extension of a productive trend, evaluation of available information by Murray (1979) indicated that the near-dome area has a poor to fair potential for future hydrocarbon production." What information was provided to Grover Murray? How long has it been since Grover Murray worked in this area? Did he bother to come into it? Did he talk with geologists in Mississippi? What and how did he determine this? If the area contains little potential for future petroleum development, why was a CDB (sic) seismic survey in progress in the area in December, 1979?

According to Dr. Murray's report to LETCo, he spoke to and visited numerous persons in the resource business including oil companies in the region. He based his analysis on past production and present exploration. This report deals with the potential at each specific dome and does not address the regional potential.

74. Page 13-28. The mineral resource potential is so inadequate as to not even warrant a discussion. Lampton Dome and its discussion by Deoeian (sic) in this report will receive little, if any, attention.

The author is somewhat unclear in this statement. Presumably he means that the discussion of the mineral resource potential in the SCR is inadequate. He refers however only to page 13-28. Another discussion of mineral resources can be found in Section 2.7.

75. Page 13-41, Richton Dome. Paragraph 1. From the information we have, Richton Dome sounds to be, in effect, a salt ridge, and not a salt dome.

As discussed in Section 13.3.1, the Richton salt stock is underlain by a large salt anticline.

76. Page 13-43, Paragraph 2. It states that the caprock contains vuggy limestones, which was interbedded with calcite and also contains several brecciated and vuggy, gypsum-rich zones. Can such a caprock provide an effective seal of the salt dome from the surrounding aquifers?

The nature of the Richton Dome caprock material is not such that it would provide an effective seal of the salt stock from the surrounding aquifers. This is consistent with the nature of caprock on many other salt domes.

77. Page 13-43, Paragraph 3. In the third paragraph, it mentions that nine wells were drilled into the salt. The salt from how many of these wells was examined in detail?

Eight of the nine wells referred to in this paragraph are sulfur exploration test wells and were drilled during the 1930's (see Table 12-1). To the best of our knowledge there are no samples available for examination, and data from these wells are limited to depths to the top of caprock and salt.

78. Page 13-45, Paragraph 2. It mentions in paragraph 2 that rough topography is present above the dome and that there are belts trending northwesterly. It should be noted that the northwesterly trend is parallel to the general fault pattern throughout this area. Paragraph 2 on page 13-45 describes the situation above the dome which contains Citronelle strata which almost certainly have been faulted. Page 13-46, first paragraph mentions the realignment of Beaver Dam Creek which can be best interpreted as the result of faulting in and around the dome.

The northwesterly trending belts of topography are parallel to the dominant northwesterly trend of the subsurface faults throughout the area. However, the shallow geologic investigations completed during the study have not indicated a correlation between topography and faulting. It is not clear what the nature of the anomalous Citronelle outcrop is in Section 24, T5N, R10W. The possibility of domal influence on the realignment of Beaver Dam Creek is mentioned in Section 13.3.2, although there are not sufficient data to draw any definite conclusions. These anomalies will be the subject of further study during Location and Site Characterization.

79. Page 13-47, Paragraph 1. "With the exception of the course divergence of Beaver Dam Creek, no pronounced drainage anomolies (sic) indicative of structural features are apparent in the near-dome area." What about the radial and centripital (sic) drainage associated with the dome itself and the nearly north-south patterns of the major streams in Perry County flowing into the Perry Basin or into the Leaf River?

A possible relationship between structural movements and the near-dome drainage pattern is discussed in Section 13.3.2.

80. Page 13-48 and 13-49. Discussion of the Bogue Homo Creek. The nature of the Creek south of the domal area sounds as though it is associated with faulting throughout the area. On 13-49, lineament studies indicate in Mississippi, according to this report, that they are not related to faults, but in Texas and Louisiana, they are. This should be questioned. Of major importance, major importance, is the statement on the bottom of Page 13-49, the last paragraph, last sentence, "One lineament, extending across the center of the dome is intersected by five shorter lineaments at acute angles, suggesting fracture patterns." Results done by many investigators, as to acute angle lineament intersections, indicates the presence of grovin-type (sic) features. This has been well documented in the literature.

The relationship between lineaments and structures within the study area is not clearly established. None of the surface projections of faults identified in the subsurface during Area Characterization were found to correlate with surface lineaments. Detailed ground truth determinations of the lineaments potentially associated with geologic structures will be performed during Location and Site Characterization.

81. Page 13-50, Paragraph 2. "Lithologic descriptions and stratigraphic correlations to depths of 6040 feet are based on petrologic and paleontologic analyses of drill cuttings and sidewall cores, ..." I have found not one mention of fossils nor any description of fossils encountered. Yet, they say they are being used.

Please refer to Appendix B-1 of the Mississippi Area Characterization Appendix volume which contains all of the paleontologist's reports used for this study. It also should be added that six other drill sites were used to collect more dome-specific data.

82. Page 14-10, Paragraph 3. "Five sites were selected for collection of regional data." The number of sites for data gathering is totally inadequate. Paragraph 4. "Multiple deep wells and a water-supply well for drilling operations were drilled at each site with the wells completed at different depths." Collecting water from multiple aquifers in a single well can cause major problems unless extreme precaution is taken.

The sentence will be rewritten to read: Multiple deep wells and a water-supply well for drilling operations were drilled at the sites with each separate well completed to a different depth. The author is unclear as to his use of the phrase "totally inadequate". Data were adequate for the area phase decision. Additional data will be gathered in the Location and Site Characterization phases.

83. Page 14-11, Paragraph 1. "Geologic data-collection sites consisted of one deep well and one shallow well that supplies water for drilling operations." This is inadequate. Paragraph 2. "Side-wall cores were taken from a limited number of wells at selected data collection sites." How many wells, how many cores, were taken?

Adequate geologic data were collected from the one deep hole at each of the geologic data-collection sites. The data included: lithologic samples, geophysical logs, sidewall cores and geochemical information. The water supply well at each drill site was used to collect additional geologic information. Sidewall cores were taken at each of the 11 drill sites. The total number of side wall cores taken in Mississippi was 482.

84. Page 14-11, Paragraph 5. Describes the regional area to be considered for our geohygrologic investigations. The area is much, much too small and the eastern boundary is far, far too close to Richton and Cypress Creek Domes.

The Mississippi study area was selected to encompass an area which included the domes of interest, not necessarily to totally include the areas which influence the domes or the areas which are influenced by them. The area studies have provided valuable insight into the geologic and hydrologic characteristics of the area, and have provided a basis, which did not previously exist, for defining the areal extent of Location and Site Characterization studies.

85. Page 14-12, Paragraph 2. Says that the Pascagoula River flows into the Gulf. It flows into the Mississippi Sound.

It flows southerly from this confluence to enter the Mississippi Sound and eventually into the Gulf of Mexico.

86. Page 14-17, Paragraph 1. "The Midway Group, however, is assumed to be the lower limit of the groundwater reservoir for purposes of this study because it contains relatively impermeable beds that hinder the flow of water between overlying and underlying formations." If faulting is present, and this study has shown the presence of numerous faults, this can not be considered valid. Paragraph 3. "The Midway Group and the basal formations of the Claiborne Group generally retard the exchange of water between the beds of the Wilcox Group and other units." This report documents numerous faults, and also documents the vertical flow of water between the units in the vicinity of faulting. Therefore, the Midway Group can not be considered a basal unit.

The depth and relative impermeability of the Midway group make it a good lower boundary for this study. To date no evidence of massive leakage through the unit or along faults exists. Wells will be drilled into the Midway in future phases of the program to determine in situ conditions. Pumping tests, geochemical analysis, along with seismic data on major faults will be used to define leakage if it exists.

There is probably no such thing as an ideal confining layer; however, a ground-water reservoir base can be deferred.

87. Page 14-19, Paragraph 2. "Gradients of this base are much steeper in the east in the vicinity of Richton and Cypress Creek Domes." This refers to the base of the fresh water. The question is why are they much deeper in the vicinity of Richton and Cypress Creek Salt Domes? Is this the location or this (sic) an indication of solution of the salt?

There is more than one possible explanation for the elevated base of fresh water near the two domes. One is possible solution of the salt. Another is that saline water is moving upward from deeper formations. A third possibility is that the dome is acting as a barrier preventing the flushing of saline water from fresh water aquifers.

88. Page 14-20, Paragraph 1. "The very saline-water surface is at its highest elevation over Richton Dome." Why? Paragraph 3. Referring to the hydrologic conductivity of the Hattiesburg Formation it is stated: "The variability was great, however, ranging between 0.8 and 904 feet per day." Unless the facies patterns of the Hattiesburg Formation is known, the results of these are totally meaningless. (Same paragraph). The regional conductivity for the Catahoula Formation was determined on the basis of only 5 aquifer tests. The Catahoula Formation is a very very variable unit and they found tremendous variations. This could very well be the result of facies.

As indicated in Item 87, there are several reasons for the elevated base of fresh water over Richton Dome. Hydraulic conductivity values average about 150 feet per day. This average is within the range, determined by the USGS, for the Miocene in Mississippi. These values will be used to determine transmissivity of the aquifer, which is dependent upon the cumulative sand thickness. Cumulative sand thickness varies greatly, but can be mapped for modeling purposes.

89. Page 14-23, Paragraph 3. "Wide permeability variations occur over short vertical distances in the Hattiesburg and Catahoula Formations." This is a most important statement.

No response is necessary.

90. Page 14-28, Paragraph 1. "Again, wide permeability variations occur over short vertical distances in the Hattiesburg and Catahoula Formations." In order to be able to evaluate this, it is absolutely essential that we know the facies patterns and all structure control within these formations.

The USGS has identified various sand units in the Hattiesburg and Catahoula formations. To determine a permeability for each unit is nearly impossible. Ranges of permeability will be assigned to the various units and a conservative approach will be used when calculating flow times and flow paths. Extensive geophysical surveys will be used to determine the structure along with data from existing borings.

91. Page 14-28, Paragraph 4. "This variability also suggests that hydraulic communication may exist between formations." Page 14-29, Paragraph 3 mentions the potentiometric surfaces. I would like to know how many data points these potentiometric surfaces are based upon.

As stated in Section 14.2.3, this potentiometric surface was based on the 41 wells drilled at 11 sites in Mississippi.

92. Page 14-36, Paragraph 3. "Brine from nearby disposal wells may account for this observed anomaly." How far away are the disposal wells from this particular site?

See Figure 14-9 for the location of MH-7 and Figure 14-12 for the location of nearby brine disposal wells.

93. Page 14-71, Paragraph 1. "Mean annual precipitation for the Thompson Creek watershed is 60 inches." Is it really two inches more than Bogue Homo Creek, only a few miles away? Paragraph 3 mentions that the domal area is drained radially by several minor tributaries. Almost certainly this is the result of faulting of the domes.

The report has been revised to describe both watersheds as receiving 60 inches of mean annual precipitation. Radial drainage patterns in southern Mississippi are common, and they usually represent topographic highs, not faulting.

94. Page 14-72. This page discusses the area subject to floods. My question here involves whether land use changes, which would be associated with the building of a nuclear waste facility (sic). Were these taken into consideration or was the flooding taken into consideration only on the basis of existing land use?

Flooding was taken into consideration on the basis of existing land use so that the domes could be evaluated on an equal basis.

95. Page 14-73, Paragraph 2. It is very important to notice that only the one well at site MRIH-11 penetrated the total thickness of the Midway Group. In Paragraph 3. It should be noted that the amount of testing in the wells at this area is totally inadequate.

Only those aquifers which were tested at other sites were tested at MRIH-11 for the purpose of aquifer characterization over the area. The author is unclear as to his use of the phrase "totally inadequate". The information gathered was adequate to differentiate between domes and reduce the number of domes under study. Additional data will be gathered in subsequent phases.

96. Page 14-74. The tremendous variability in the saline content between the Upper Wilcox and the Lower Wilcox is of extreme importance. Only one test well was completed in the Catahoula Formation. Water pumped from this site was saline.

The differences in salinity content between the Upper and Lower Wilcox may indicate lack of hydraulic communication between these two aquifers.

97. Page 14-76. This page discusses the regional variability of the hydrologic properties of the Hattiesburg Formation. I have serious reservations as to whether this can be done on the basis of only three wells. It is important to note that water pumped from the caprock was saline. Pumpage from the caprock in paragraph 3 indicated vertical connection of aquifers.

Table 14-2 shows 10 tests in the Hattiesburg Formation. The possibility of vertical connection between the caprock and overlying Hattiesburg Formation at Richton Dome is mentioned in the referenced paragraph.

98. Page 14-77. It is important to note that the movement of ground water in the caprock is associated with fractures, joints and solution channels. It is also important to note that several solution caverns were observed in the upper part of the caprock core.

Solution channels (not "caverns") were observed from cores taken in the upper part of the caprock at Richton Dome. These channels were generally less than 10 mm in size.

99. Page 14-78. Documents the vertical movement of water throughout the area. Paragraph 1 states "The head distribution at site MH-4 south of the dome suggests that upward flow is occurring at this site throughout the depth of the aquifer system." Paragraph 2. "The shape of the fresh-water base reflects the presence of the dome" Paragraph 3. "The fresh-water base remains relatively high in the Miocene deposits south of Richton Dome in the area between Richton and Cypress Creek Dome." This is almost certainly the result of a plume.

Paragraph 3 states possible causes for the elevated base of fresh water. More information is needed to clarify this issue. This anomaly will be investigated further during Location and Site Characterization.

100. Page 14-79, Paragraph 1. "Further investigation is needed to explain the reasons for the high freshwater base south of Richton Dome." I agree. Paragraph 3. "The desire for quantitative answers and the lack of some specific data dictated a procedure requiring a number of assumptions." This is the understatement of the year!

The Appendix states these assumptions and the conservative numbers used to estimate flow times.

101. Page 14-80, Paragraph 2. "The vertical flow velocity averaged about 0.005 feet per year." I believe there is insufficient data to make such statements.

This statement has been changed to read: The estimated vertical flow velocity averaged about 0.005 feet per year.

102. Page 14-81, Paragraph 1. "Flow through secondary openings such as joints or fractures was not considered in this analysis." Because of the lack of this consideration, I contend that the entire evaluation is of little, if any, value.

This was stated as an assumption used in the flow analyses. [This test was designed to determine vertical water velocity relative to horizontal velocity for the strata around the domes.] A more detailed, multidimensional model will be developed during the Location and Site phases.

103. Page 14-84. I contend that the two water wells discussed in paragraph 2 are of major importance. Paragraph 5. Only tow data collection sites were located at Cypress Creek Dome? Perhaps three?

We agree. These will be studied during Location and Site Characterization. Three sites were intended to collect data from an "area" near the dome, not to fully characterize the dome. Site characterization will be addressed in future investigations.

104. Page 14-86, Paragraph 1. Is the mean annual rainfall at Cypress Creek three inches higher than Bogue Homo Creek? Therefore, we have the case to document the connection of aquifers.

We are not sure that rainfall variations across three distinct drainage basins have anything to do with connection of aquifers.

105. Page 14-92, Paragraph 1. "The shape of the freshwater base appears to be altered only slightly by the presence of the dome." I contest this statement.

This statement is referring to Cypress Creek Dome's effect on the base of fresh water. Figure 14-5 shows that the dome has little effect on the base of fresh water contours.

106. Page 14-94, Paragraph 2. "It is possible that the salt dome is contributing to the anomalous chemistry of the waters in Miocene deposits in this region." There is evidence of subsidence over the dome. This subsidence could have been caused by salt dissolution.

Section 14.3: "It is possible that the salt dome is contributing to the anomalous chemistry of the waters in Miocene deposits in this region. There is evidence of subsidence over the dome (Chapter 13, Section 13.1.2.3). This subsidence could have been caused by salt dissolution."

Comments on Mississippi Final Draft Area Characterization Report by Kenneth J. Goodwin of the Mississippi Research and Development Center, with Replies

1. I find a complete void of socio-economic information, yet some domes in other states were eliminated using socio-economic related criteria. The Richton Dome is located in close proximity to a population center, yet no mention is made of this extremely important criterion.

Reference is made to the proximity of Richton Dome tc the town of Richton in Section 13.3.2. An evaluation of the Mississippi Study based on socio-economic data is beyond the scope of the Volume IV Geologic Area Characterization Report. Socio-economic and environmental considerations are addressed in the Environmental Area Characterization Reports.

2. In the area of mineral production and potential, conflict and errorneous statements exist. Statements are made in several places that no potential exists for the development of mineral interests. Several years ago, Diamond Shamrock Company optioned a portion of the Richton salt dome as well as 2000 acres of land in Jackson County for a production facility to convert salt to various industrial uses. They were also considering the dome for storage of their finished liquids and gases. Only a change in major company direction caused this project to be cancelled. Several other industrial prospects have looked at the domes and an industrial prospect of a confidential nature is currently looking at the domes.

The Area Characterization Reports recognize that there is some potential for development of mineral resources at salt domes, and that utilization of a salt dome for a repository would preclude development of those resources. At the Area Characterization level of studies, it was intended to determine whether any of the domes under consideration contained significantly greater resources than other domes, and to develop sufficient data to evaluate whether use of the dome would result in a significant loss of resources.

With respect to extracting salt and utilizing the resulting cavity for storage, the potential for such usage would be similar for all shallow domes.

Comments on Mississippi Final Draft Area Characterization Report by Eddie S. Fuente of the Mississippi State Board of Health, with Replies

1. At this time I would like to make a comment on the work that has been completed. Approximately 75 test holes were drilled in the MSA to determine specific geological information. The Division of Water Supply, MSBH requires all water well drillers to plug all abandoned test holes and wells with cement grout to prevent aquifers (sic) communication. Since all of the public water supplies in this area use ground water sources, we would like to see the records of plugging for these test holes. Mixing of water from different formations has the potential of causing extreme treatment problems in present or future ground water supplies for potable use. We feel with the concentration of holes in this area, these holes should be properly abandoned to assure the integrity of our public water systems.

As a requirement for the Mississippi Oil and Gas Board permitting, the permit holder is required to show that the wells are properly plugged before abandonment. The wells will be transferred to ONWI in November or December 1981, and they will assume all responsibility and liability to plug all wells before abandonment.

2. In Paragraph 5, statements are made indicating the recharge areas were identified. How were these areas defined? Information presented in these reports does not indicate the boundaries of these recharge areas. What is DOE's position on determining the boundaries of the recharge areas?

Recharge areas were identified from outcrop areas that were described in previous reports by the USGS. Most of the recharge areas of the major aquifers systems have been mapped and are located outside and north of the study area. A geologic outcrop map is included in the report that shows boundaries of the Miocene and younger formations in the area. Other sources of recharge may exist, such as leakage from other aquifers. However, these may be very local and, therefore, without specific long-term pumping tests and geochemical analysis, identification is difficult. Outcrops at the surface will be major recharge areas in the Gulf Coast.

Comments on Mississippi Final Draft Area Characterization Report by the Mississippi Department of Natural Resources, with Replies

1. The short time which the Mississippi state agencies have had to review these documents has hampered an in-depth technical review. Adding to this problem is the fact that the appendices for the three area characterization study areas were submitted more than a month after the text, figures, and environmental characterization reports. When the appendices did arrive, they were found to contain only a portion of the data necessary to review the geologic characterization findings, assumptions, and conclusions presented in the reports. For example, the Mississippi appendix contained boring logs of only 19 of the 85 shallow borings made at Richton and Cypress Creek Domes in the Mississippi Study Area. This is a significant deficiency because we have identified some problems in the interpretation of data on the cross sections that traverse the domes. In another matter, petrographic analysis reports of core samples have not been received as of this date.

The Mississippi Area Characterization Appendix Volume contains 19 shallow boring logs which contain representative data from each series of the shallow boring program. In compliance with a Freedom of Information Act request by the Mississippi Attorney General, all of the data obtained in Mississippi were forwarded to the State of Mississippi during 1980 and early 1981.

2. Alternate geologic interpretations are not adequately presented. In certain cases it is possible to use the given data and illustrations to argue for a conclusion exactly opposite that presented in the text of the report.

The main purpose of the Geology Section of the Area Characterization Report was to describe the geology of the study area. When adequate data were available, interpretations were developed to explain the present geological conditions. Where alternate interpretations existed (e.g., Section 12.2.3.3, Wiggins Anticline), they were included. The possibility for many interpretations in some cases is recognized, but the inclusion of all of them is beyond the scope of this report.

3. The selected boundary of the Mississippi Study Area is inadequate. The area encompases 1440 square miles, but Cypress Creek and Richton Domes are both within two or three miles of the boundary. Surely we are more in need of a geologic and hydrologic characterization, for example, in southeastern Jones County only two miles from Richton Dome than for the central part of the study area which is 20 miles from any of the three study domes.

BEST DOCUMENT AVAILABLE

The Mississippi study area was selected to encompass an area which included the domes of interest, not necessarily to include totally the areas which influence the domes or the areas which are influenced by them. The area studies have provided valuable insight into the geologic and hydrologic characteristics of the area, and have provided a basis, which did not previously exist, for defining the areal extent of Location and Site Characterization studies.

4. On page 12-42 or Volume IV A it is stated that Cornell University is currently reviewing the Holdahl-Morrison data; we have not seen a copy of the Cornell report. A verdict on the Holdahl-Morrison data is vital to any conclusions about the probability of breaching of the Mississippi salt domes that may be derived.

The implications of the Holdahl and Morrison data with respect to rapid uplift in the Gulf Coastal Plain are not supported by geomorphic or other evidence. Any re-evaluation of the probability of breaching of the Mississippi salt domes by regional uplift will be conducted as a result of the Cornell review, currently in progress.

5. The Area Characterization Report gives an inadequate overview of the seismicity of the Mississippi study area. The number of earthquakes affecting Mississippi is insufficiently considered. The assignment of Modified Mercalli intensity VI as the maximum effect to be expected is not conservative enough (too low an intensity).

Each earthquake in Mississippi and surrounding states has been reviewed in detail. The significance and potential impact of these earthquakes have been analyzed using NRC approved earthquake recurrence estimating procedures.

6. Section 12.2.4 of Volume IV A discusses the seismicity of the study area; it offers very little not already discussed in Volume I. All that is different is a list and map of Mississippi area earthquakes and an analysis of the possibility that two locally-felt, post-1930 earthquakes may have been induced by operations at some oil and gas fields. The latter analysis was done because oil-field activity has been known to trigger earthquakes (at some localities) and because no structures or tectonic features near the Mississippi study area are known to have

generated earthquakes. None of several legitimate associations of earthquakes with structural features in Mississippi was analyzed. An association of earthquakes with these features has not been proven, but neither has it been disproven; the Area Characterization Report is deficient in not having properly analyzed known facts.

One of the purposes of the ACR was to correlate earthquake epicenters with geologic structures (Sections 2.5, and 12.2.4.3). All apparent associations between earthquakes and geologic structures were evaluated. This analysis of possible associations produced only one credible correlation, and that was with oil and gas production. The discounted associations were not documented in this report.

7. The seismicity and seismic risk analysis in Volume IV (Mississippi) is summarized in two sentences on pages 12-83 and 12-84. (1) "The candidate domes in the Mississippi Salt Basin study area can expect a maximum ground motion surface intensity of VI MM." This statement is derived from the discussion presented in Volume I, and is based on the premise that the largest earthquake in the Interior Salt Basin earthquake "region" was of intensity VI. In view of (a) the ongoing (long-term) earthquake activity at the intensity VI or VII level in and around Mississippi, and (b) the fact that present knowledge does not allow us to discount the possibility of a New Madrid type earthquake (intensity XII) occurring at any time in the southeastern Missouri - northeastern Arkansas - western Tennessee - northwestern Mississippi area an estimate of intensity VI as the maximum to be expected from the maximum credible earthquake is not conservative.

All of the earthquake activity in and around Mississippi was thoroughly investigated. None of the recorded events in this area attenuates to greater than a VI MMI at the site, nor do any of the "New Madrid-type" earthquakes attenuate to greater than VI MMI at the site from the bounding seismotectonic regions.

8. On page 12-84; "No tectonic features capable of generating earthquakes were identified within the study area." That statement does not add to a geologic characterization because it raises several questions (about the sentence, not the facts). What is meant in that sentence by "study area"? Is it the Mississippi Study Area as shown on Figure 12-1 or is it the 200-mile radius circle used in the earthquake list and location map (Figure 12-31)? Nowhere in the Area Characterization Report or in

guideline criteria such as ONWI-33(2) is there a definition of such a tectonic feature. It must be pointed out that in the discussion of one of the two oil-field-associated earthquakes it is stated (page 12-82) that the "epicenter is 3 kilometers north of the Pickens-Quitman-Gilbertown-Pollard Fault Zone." Since the positional uncertainty of that and other area earthquakes is greater than 3 kilometers, a plausible supposition not mentioned in the report is that the earthquake may have been located on the fault zone and merely triggered by oil-field activity.

The following is NRC's definition of a "capable fault" as published in 10 CFR 100 - Appendix A, III (g):

"A 'capable fault' is a fault which has exhibited one or more of the following characteristics:

(1) Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.

(2) Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.

(3) A structural relationship to a capable fault according to characteristics (1) or (2) of this paragraph such that movement on one could be reasonably expected to be accompanied by movement on the other.

In some cases, the geologic evidence of past activity at or near the ground surface along a particular fault may be obscured at a particular site. This might occur, for example, at site having a deep overburden. For these cases, evidence may exist elsewhere along the fault from which an evaluation of its characteristics in the vicinity of the site can be reasonably based. Such evidence shall be used in determining whether the fault is a capable fault within this definition.

Notwithstanding the foregoing paragraphs III (g) (1), (2) and (3), structural association of a fault with geologic structural features which are geologically old (at least pre-Quaternary) such as many of those found in the Eastern region of the United States shall, in the absence of conflicting evidence, demonstrate that the fault is not a capable fault within this definition."

The study area in the statement is the Mississippi study area. This does not mean that adjacent areas were ignored. The seismotectonic region method includes damage expected from distant earthquakes.

9. Quaternary faults. Although no faults cutting Quaternary sediments are known from the Mississippi study area, undiscovered faults may exist.

> The faults would probably be difficult to detect in unconsolidated, fluvial deposits. Surface effects of even fairly young faults could be obscured by surface processes. Some information in the Area Characterization Report should be mentioned, however.

We agree that undiscovered faults may exist, and that this is due to the lack of widespread correlatable marker horizons in the fluvial deposits. Additional studies to further define the extent of faulting will be conducted during Location and Site Characterization.

10. The fault cutting the Hattiesburg Formation (probably Middle Miocene or younger) on shallow geologic sections Y-Y' (Figure 13-57) is extended almost to the ground surface. The overlying Citronelle Formation is not mapped as being present at that location, so there is not physical evidence upon which to set a "not-later-than" data (sic) for the fault. On page 13-57 of Volume IV A it is stated that fault F-7 at Richton Dome, when projected to the surface, is nearly parallel and coincident with Bogue Homo Creek, which could indicate recent faulting.

The shallow boring program was interrupted by a request by the State of Mississippi to increase field work before the fault shown on Figure 13-57 could be adequately investigated. Further studies of this fault and others (including F-7) will be undertaken during Location and Site Characterization.

11. As referenced in the discussion under Criterion I, the precise leveling data of Holdahl and Morrison indicate ongoing uplift of two to four mm/year in the Mississippi study area. This uplift is attributed to crystal movement and not to local causes. The consequences of this uplift were not adequately discussed in the Area Characterization Report.

As indicated in the response to Item 4, a discussion of the consequences of this postulated rapid uplift will be reserved until verification of the Holdahl and Morrison data by Cornell University.

12. It is stated on page 13-59 of Volume IV A that at Richton Dome "No clear evidence of domal movement was found on the Hattiesburg-Citronelle contact (Figures 13-57 through 13-61) which slopes to the east and southwest from the domal crest." Actually, those very figures (geologic sections and a structure contour map) do seem to indicate Miocene or even post-Citronelle doming at Richton Dome.

The contact between the Hattiesburg and Citronelle Formations is described in Section 13.3.2 as being erosional due to channeling of the Hattiesburg surface. Figures 13-57 through 13-61 support this interpretation, and the lack of post-Miocene dome growth is evidenced by the relatively flat-lying geo-electric units within the Miocene Hattiesburg Formation.

13. On page 13-63 of Volume IV A in the summary of Chapter 13 (geologic characterization of Richton, Cypress Creek, and Lampton Domes), there is stated a conclusion that Cypress Creek and Richton Domes are stable because studies of Pleistocene terraces "do not indicate dome growth at these two domes during the Quaternary Period, which involves about two million years." This conclusion is by no means warranted by the evidence presented. The ACR implies that studies of two million year old sediments have proven lack of movement at the domes in that time. In reality, the studies at the two domes of the Pleistocene terraces, which may be only a few thousand years old, were inconclusive.

The entire sentence reads: "Limited studies of Pleistocene terraces at Cypress Creek and Richton do not indicate dome growth at these two domes during the Quaternary Period, which involves about two million years." Depending on which reference one consults, the Quaternary period may be at least two million years old. While it is true that the youngest terrace levels in the study area may only be several thousand years old, none of the several terraces examined from the Citronelle (which is Plio-Pleistocene) to Recent, indicated deformation.

14. Of utmost concern is the almost total lack of seismic instruments anywhere close to the Mississippi study area. No seismic instruments were set up in Mississippi during area characterization, although a microseismic monitoring unit was set up in Texas (Volume II A, page 6-43). The lack of information about seismic (particularly microseismic) activity in the Mississippi salt basin is more an artifact of this lack of instrumentaiton than a lack of activity. Information about the known earthquakes of southeastern Mississippi (especially precise eipcentral location and focal depth) is poor due to the shortage of instruments.

Information about salt tectonics in Mississippi is also poor. One matter of concern to us is that during the Area Characterization phase tiltmeters were installed and utilized in Louisiana but not in Mississippi.

To derive useful data from seismic and tiltmeter instrumentation, it is important to obtain as long a period of record as possible. A record of two years, for example, may not detect events that occur at approximately

> four-, ten, or fifty-year intervals. A seismic array should have been installed in the Mississippi salt basin (and tiltmeters over the candidate domes) during the area characterization phase and kept operational until final repository decisions are made.

We agree that a seismic monitoring array should be activated in the study area. This will be accomplished in the location phase. The Site Characterization plan calls for a network of portable microseismic recorders to be installed in Mississippi to investigate the seismic activity. Also a stationary seismic station has been proposed for the areas near the domes. These stations will continue in operation until a final decision is made concerning the domes.

15. Figure 14-17, Volume IV B, is a graph showing the relation of travel time along a vertical path to depth at the three Mississippi candidate dome sites. This method of analyzing vertical flow time has been criticized by members of the U.S. Geological Survey to State officials. According to USGS officials, travel times depicted on Figure 14-17 are based on two assumptions. (1) The repository containment area is breached and radionuclides arrive at some point in the sediments adjacent to the repository level. (2) Travel times are computed for the nuclides to reach the base of the fresh water using available hydrologic data and assuming a vertical path through aquifers, aquitards, and aquicludes. This method ignores a more probable path. If a repository were breached, allowing radionuclides to migrate laterally to the outer limits of the salt stock instead of arriving at a hypothetical point in the adjacent sediments, a more probable path would be for the radionuclides to migrate vertically through a porous zone (anhydritic sand) between the salt stock and the caprock sheath, then enter the biosphere through fractures, joints, solution channels, or other porous zones in the caprock. Indications of a porous salt/caprock contact several feet thick can be seen in cores and well logs taken from both Cypress Creek and Richton Domes. Tatum Salt Dome, located in the western portion of the Mississippi study area, is reported to have a section of loose anhydritic sand 432 feet thick between the salt and the caprock (1973-USGS open file report 4339-2). The caprock occurs not only on top of many domes but occurs also along the flanks of the dome (1980-USGS open file report 80-595). Little is known about the ground-water hydrology adjacent to the three domes selected for more intensive geohydrologic studies (Richton, Cypress Creek, and Lampton) (USGS open file report 80-595).

The vertical flow time analysis was prepared in order to determine if there were any significant differences in estimated travel times in the sediments near each of the candidate domes in Louisiana, Texas, and Mississippi.

The flow time analysis was based on a scenario that placed the waste outside the dome so that flow characteristics of the sediments, not the dome, could be compared. The Key Issues Phase and and the Site Characterization Phase of study will consider near-dome and caprock flow potentials.

16. It is stated in ONWI-33(2) Site Qualification Criteria: "The repository site shall have subsurface hydrologic and geochemical characteristics compatible with waste isolation." The studies conducted thus far on behalf of the DOE have been extensive enough to determine adequately the subsurface hydrology and geochemistry for the Mississippi Study Area, much less for the area around the three candidate domes. The data acquired thus far are inconclusive. The sparse data used in determining the rate of movement, direction of movement, and geochemical characteristics of the groundwater in the Mississippi Study Area can not be considered to be representative of formations throughout the study area. The data used in calculating the hydrologic conductivities show too much variability to make an accurate determination of ground-water movement in the study area or in the area of the three candidate domes. These figures can be considered to be only representative of hydraulic conductivities in the immediate areas of the test wells and not regional characteristics. Only one aquifer test was performed on the Cockfield Formation and it indicated that the unit has poor water-transmitting properties. Since the aquifer tests on other formations showed such high variability (i.e., 0.8-904 feet/day), the figures for the Cockfield should not be used as representative data until further aquifer tests are conducted.

An analysis of aquifer tests from individual wells over a large area is considered an acceptable method of regionalizing hydraulic characterisitics. Newcome (1971)[1] published aquifer characteristics for all aquifers in Mississippi. Values obtained for the Miocene aquifers were comparable with Newcome's report.

The Cockfield Formation is comprised predominantly of clay in this region. The single aquifer test for the Cockfield indicated that it had hydraulic characteristics of a clay.

17. The chemical analyses indicated some figures for Total Dissolved Solids (TDS) are higher than would be expected. In DOE-MRIH-11 A, B, C, and D the TDS and chloride levels in the Catahoula Formation are higher than in the underlying Cook Mountain Formation. The TDS and chlorides are higher in the Sparta than in the Wilcox. No explanation is given in the ACR.

---

[1] Newcome, Roy, Jr., 1971, Results of Aquifer Tests in Mississippi: Mississippi Board of Water Commissioners Bulletin 71-2, 44 p.

> Does this indicate that dissolution of the salt dome has elevated the TDS and chloride levels in these formations? Further test wells should be drilled to determine the reason for these elevated figures. The Sparta should be tested at the MRIH-11 site or at some point on the southern flank of the Richton Dome to determine if a saline plume exists in the Catahoula or in the Sparta. The salinities south of Cypress Creek Dome are very elevated in the Lower Miocene and Cook Mountain. No explanation is given for these elevated figures. Is this situation due to dissolution of the dome?

The anomalous higher TDS found in the Catahoula Formation at site MRIH-11 was not found at any other site. The reason this anomaly was not explained in the ACR was that there were not enough data to lead to any conslusions. The issue of dome dissolution at Richton and Cypress Creek will be studied in detail during the Location and Site Characterization Phase of the study.

The Site Characterization Plan outlines the program to address this anomaly.

18. Prudence requires careful and thorough analysis of available hydrologic data and of data still to be obtained. Many extremely significant uncertainties exist in our knowledge of the hydrologic system in the Mississippi study area. In Volume IV A, for example, after a discussion of the wide permeability variations that occur over short vertical and horizontal distances in several units, it is stated on page 14-28 that "This variability also suggests that hydraulic communication may exist between formations." This situation must be investigated thoroughly. Any hydraulic communication between any units between the surface and at least repository depth will be of great concern. Upward movements of groundwater are especially disconcerting, and evidence apparently exists of such movements at the Mississippi salt domes. In a talk at the 1981 meeting of the Mississippi Academy of Sciences, a hydrogeologist who participated in the studies indicated that existing data prove movement of water between formations, including an upward component of the movement in the vicinity of Cypress Creek and Richton Domes.

Upward components of ground-water flow exist near Richton Dome. What is not fully understood is the degree of aquifer connection and discharge areas for the saline aquifers near Richton and Cypress Creek Domes. This will be addressed in Location and Site Characterization.

19. On page 14-30 of Volume IV A it is stated that: "Observed alterations in the potentiometric surfaces that have been caused by man's activities must be considered to be transient. These changes will most certainly only exist in a time frame of tens to hundreds of years." No basis is given for these statements, and they can not be supported. While the statements may have some validity regarding pumping and injection in oil fields, they are very short-sighted when one considers the potential for groundwater withdrawal, deep-well waste injection, or even subsurface petroleum mining. Man's use of groundwater in the area could continue for the next several centuries in existing patterns or in different patterns. Alterations in the potentiometric surfaces may become more severe than they are today. Man has occupied southeastern Mississippi for hundreds of years already and may for centuries more. Some parts of the world have records of human occupation (including urban) for two thousand years or more. Hydrologic conditions under a variety of possible and plausible future scenarios (such as greatly increased use of fresh and even brackish water) must be considered. Since the area characterization study failed to do so, it must be done in the location characterization phase.

This statement will be deleted from the text. Ground-water stresses near the domes will be studied further during Location and Site Characterization.

20. Another problem related to hydrologic characterization that was not adequately considered concerns brine disposal operations at Glazier, Camp Shelby, Sand Hill, and Ovett fields (all disposing into the Wilcox) (page 14-66 of Volume IV A). These operations could present problems of alterations of ground-water flows, pressures, etc. Nowhere in the ACR is there any mention of plans to control oil-field activities within any set distance of a repository. Incidentally, it is believed that injection at Baxterville Field caused a flow of brine up a boring and out onto the surface at Tatum Dome. Figure 14-12 does not show the injection wells at Sand Hill and Ovett fields because they are out of the study area - a specific example of a defect in the drawing of the study area boundary. Also, Table 14-7 does not list these wells. The data in this table are incomplete and possibly out of date.

Figure 14-12 does not show injection wells at Sand Hill and Ovett Fields. The figure has been changed to show these. Table 14-7 has also been changed to list these wells. Location and Site Characterization Studies will address the problem of brine injection relative to the regional ground-water model.

21. Although evidence about several locations of upward flow of groundwater at Mississippi domes is mentioned at more than one place in the ACR, the serious implications of this movement are not emphasized adequately in the conclusions for Chapter 14 of Volume IV A (Mississippi study area) or in the conclusions in Volume I (Gulf Coast Salt Domes Project).

Implications of vertical ground-water flow near Mississippi domes applies to both regional (discussed in this report) and near-dome assessments. The Site Characterization Plan discusses ground-water flow path investigations at length. Aquifer testing and geochemical analysis will provide answers as to the location and amount of upward leakage. At that time a complete discussion of the results and implications can be made.

22. It is not clear whether or not individual hydrologic units above the domes within the Hattiesburg Formation have been identified nor is there any mentioned in Volume IV of potential repository shaft design with respect to local hydrology.

Detailing of hydrologic units and their physical properties were not discussed, nor studied in detail in Area Characterization. Over-the-dome hydrologic units and their relationship to shaft design will be studied during Location and Site Characterization.

23. A solid contact between salt and anhydrite, which is said to be characteristic of salt-caprock contact over most of one dome (Boling Salt Dome, Texas), is evidence of a cessation of salt dissolution (E. J. Newchurch, An Investigation of the Utility of Gulf Coast Salt Domes for the Storage or Disposal of Radioactive Wastes, 1976, page 20).

Neither Richton or Cypress Creek Dome display a solid contact between the salt mass and caprock. This anhydrite zone, at both domes, does not mean current dissolution is taking place. Salt dissolution will be studied in detail during Location and Site Characterization.

24. There is an indication of a possible saline plume south of Richton Dome. The fresh-water base remains relatively high in the Miocene deposits south of Richton Dome in the area between Richton and Cypress Creek Domes (ACR Volume IV A, page 14-78). Saline water at high elevations in the Miocene deposits south of Richton Dome might be expected if salt dissolution is occurring at the dome (ACR Volume IV A, page 14-79).

The high base of fresh water south of Richton Dome and the chemical anomaly at site MRIH-11 will be studied in detail during Location and Site Characterization.

25. On page 14-76 of Volume IV A it is stated that evidence has been found of hydraulic connection between Richton Dome caprock and Hattiesburg Formation aquifers overlying the caprock.

The only evidence of hydraulic connection between the caprock and overlying sediments were found during drawdown tests in the upper part of the caprock where fractures occur.

26. When reviewing the information, we identified a number of discrepancies or errors in the plotting or interpretation of the basic test hole data. In an attempt to resolve the problems, we referred to the Mississippi Appendix volume but found the shallow boring data to be incomplete. Of the 85 shallow borings made at Cypress Creek and Richton Domes, only 19 "representative" logs are given in the appendix. As this was insufficient data with which to check the validity of the information presented on the Richton Dome shallow geologic sections and structure contour map (and the interpretations/conclusions drawn therefrom in the text), we set about obtaining the rest of the shallow boring data. These data had still not been received by this office as of March 31, 1981, the deadline for ACR comments to be submitted to DOE.

The shallow geologic cross sections have been reviewed and corrections have been made where necessary. Our interpretations have not changed. The shallow boring raw data were transmitted to DOE prior to November 30, 1980. The data were transmitted to the Mississippi E&T Board.

27. A consideration not adequately addressed in the Area Characterization Report is that geologic and stratigraphic modeling will be very much more difficult at a salt dome than at a site in bedded salt or some other rock type. A good determination of the stratigraphic setting in the vicinity of a dome may be obtained through drilling and geophysical methods, but that is not the case at the dome - country rock interface. The nature of the interface, including such vital information as the presence or absence of a caprock sheath or zone of anhydritic sand, can not be determined satisfactorily without the drilling of so many test holes as to jeopardize the integrity of a dome as a repository site.

A detailed investigation of the nature of the salt stock -- country rock interface on the flanks of the dome is beyond the scope of the Area Characterization studies. Data used to describe the caprock-sediment contact were obtained. More detailed modeling will take place during Location and Site Characterization.

28. The host-rock should be shown to be compatible with anticipated chemical, thermal, and radiological stresses involved in waste/rock interactions. The Area Characterization Reports have not addressed this issue.

This is beyond the scope of the Area Characterization Report. These studies are being conducted by other ONWI contractors, such as RE/SPEC and Westinghouse. Their reports are available through the ONWI library.

29. In a time of dwindling supplies of fresh usable groundwater, this report apparently does not consider fresh groundwater a mineral of potential economic significance, nor does this report address the effects repository construction may have on local groundwater.

Ground-water usage is recognized as important and more detailed evaluations of present and future ground-water usage will be addressed in progressively more detail during Location and Site Characterization. The effects of repository construction on local ground water can be mitigated by design of the shaft, seals, and surface facilities.

30. It may be difficult to impossible to predict the value future generations may place on minerals associated with salt domes located in the Mississippi study area. The value placed on these minerals by this study may be far too conservative even for present and very near future generations.

Cypress Creek Dome is a relatively recently discovered dome and economic exploration has not achieved the same level here as at other domes. Production has been achieved from three wells directly associated with the dome. A greater demand for petroleum products may invite deeper drilling or denser exploration drilling.

The supplies of mineral aggregates, especially concrete gravel meeting ASTM standards, have been dwindling in recent years primarily due to the increased construction of highways and house foundations. Although mining of mineral aggregates near a repository site would have little or no effect on the salt structure, it is reasonable to assume that deposits located within a restricted area will be lost from production forever for security reasons.

It is recognized that the use of a salt dome for a repository will require withdrawal or some resources from the resource pool. At the Area Characterization level of study, it was intended to determine whether any dome contained significantly greater resources than the other domes under consideration, and to develop sufficient information to allow an evaluation of whether the use of a dome would result in a significant loss of resources.

31. Before the potential for lignite production over or around salt domes is excluded from consideration, a study should be done concerning the feasibility and the present state of the art technology concering in-situ lignite gasification. Concerning the ACR assumption that only the deeper Claiborne or Wilcox Groups contain lignite beds thick enough for commercial development, it should be pointed out that thick lignite beds were encountered in Miocene deposits over and in near contact with the caprock at Tatum Dome (D. H. Eargle, Geology of Core Hole WP-4, Tatum Dome, Lamar County, Mississippi, 1962 - Dribble-19). In ascending order above the limestone caprock lignite beds were identified in core hole WP-4 at 885' - 916', 832' - 839', 815.5' - 817.5', 809.5' - 812', 806' - 809', 794' - 804', and 784' - 790'. The cumulative thickness of lignite described by Eargle in the Catahoula Sandstone above the Tatum Dome caprock between the depth of 784 and 930 equals approximately 55 feet. Unpublished drilling logs by this agency identified lignite beds of similar depth and thickness in well HM-3 at Tatum Dome.

Additional drilling during Location and Site Characterization will better define the lignite potential near the candidate salt domes. Resource potential of the study area was addressed during the area phase and will continue to be a factor in the decision process.

32. Thirty unsuccessful sulfur test wells were drilled into the caprock at Richton Dome during late 1944 and early 1945 by Exploro Corporation, later called Minsearch Corporation (ACR Volume IV A, pages 13-43 and 13-61). Eight of these wells and one Law Engineering well, MRIG-9, penetrated the salt stock. The Area Characterization Report does not address the issue of whether or not these wells will have an unacceptable adverse impact on repository performance. Also, neither does this report comment on the disposition of these wells.

The Mississippi Area Characterization Report describes the significance of the 30 sulfur test wells drilled into Richton Dome in terms of the geologic data obtained from them. Wells which penetrate the caprock and extend only a few feet into the salt are not believed to present any hazard to the integrity of the salt stock.

The NWTS program has, for several years, supported research on effective plugging of boreholes and wells. One issue for Location Phase studies is to relocate all the sulfur test wells on Richton Dome and to examine the adequacy of their plugging.

☆ U.S. GOVERNMENT PRINTING OFFICE 1982-559-099/5348